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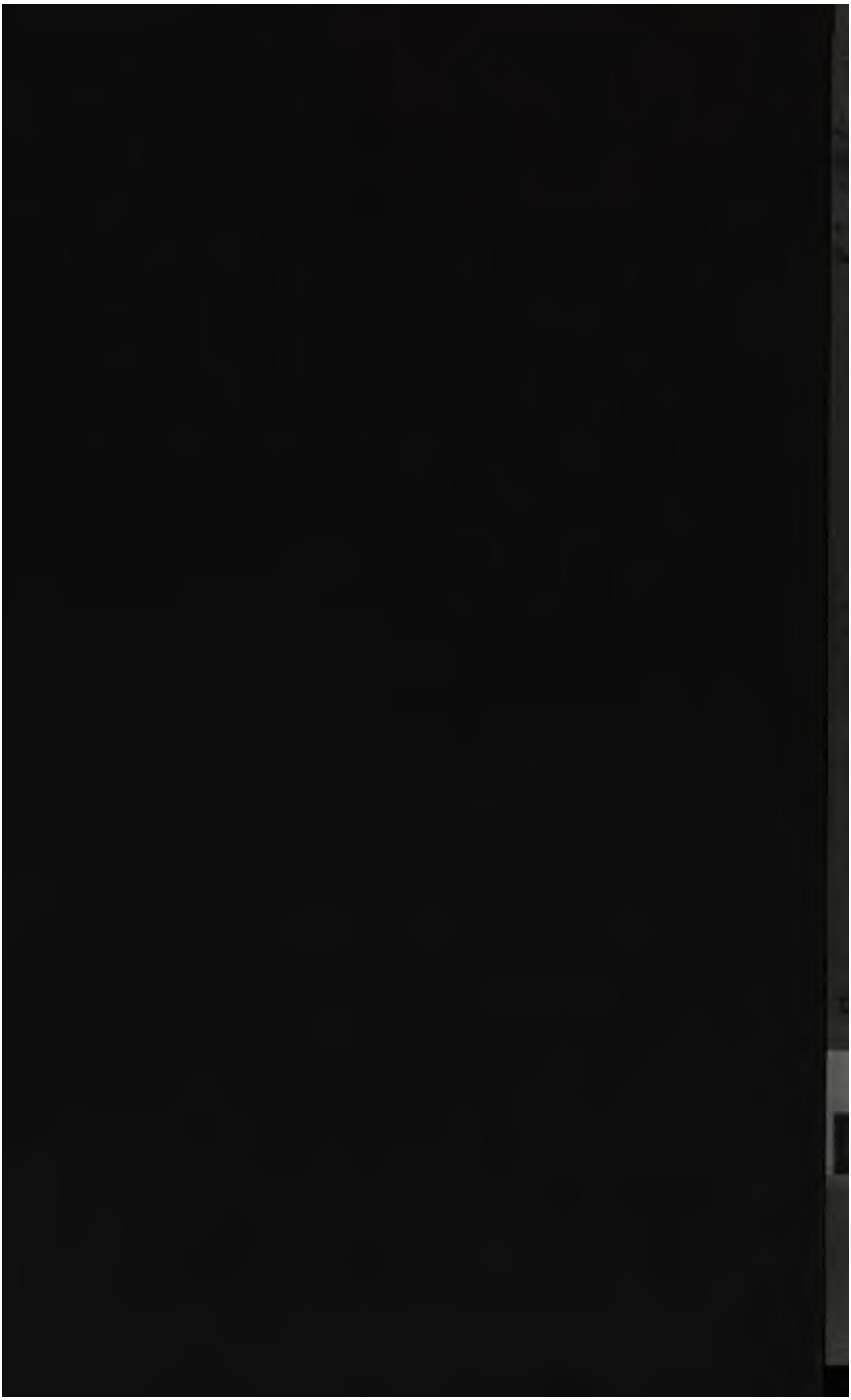

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REPORT

OF THE

NTOMOLOGICAL DEPARTMENT

OF THE

New Jersey
ricultural College Experiment Station

New Brunswick, N. J.

BY

JOHN B. SMITH, Sc.D.

For the Year 1907.

TRENTON, N. J.
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REPORT OF THE ENTOMOLOGIST.

Report of the Entomologist.

BY JOHN B. SMITH, SC. D.

GENERAL REVIEW.

The conditions of temperature and precipitation varied considerably in different parts of the State. In a general way it was dry, or even very dry north of the red shale line, until well along in July. In the southern areas there were showers in plenty; but irregularly distributed, so that there might be a flood in one locality, while another in great need of moisture received nothing. After midsummer there was an abundance of rain throughout the State. Spring came in slowly and with many late frosts after a period of early warmth. Frosts began early and followed each other in rapid succession from early October.

The results upon insect development were interesting. Everything was late in starting, and for a time decidedly irregular; but as the season advanced, those insects that normally came late arrived on time, and found as companions a series of species which in other seasons were well out of the way. There was no startling outbreak of any kind, and quite a number of the species that are usually troublesome were conspicuous by their absence, or greatly reduced numbers. Scale insects, as a whole, did not do well; potato beetles were very late in making their appearance and did much less injury than usual; cut-worms did much less injury than usual, and root-maggots were not nearly so abundant as in 1906. On the other hand, different species became much more abundant than for some years past. The bagworm on shade trees and hedges; the fall web worm on orchard and road trees; plant lice of various kinds on field and orchard

crops; the corn-worm, and a variety more made up very fairly for the deficiency of the rarer species.

In the general work of the office a large number of questions were answered, specific advice was given and minor investigations were made that do not show for much, yet take a great deal of time and are of direct benefit. The experiments with root-maggots were continued to complete our knowledge of the habits of the insects under varying conditions and to test certain of the insecticides more fully under field conditions. So, also experiments with and tests of insecticides have been continued, and some interesting results were secured. It has proved possible, this season, by co-operating with the inspection work of the State Entomologist, for Mr. Dickerson and myself to verify the claims made for crude carbolic acid as a scale destroyer, and also to observe more closely than ever before the results of ordinary orchard spraying operations. In a number of cases applications were made at my suggestion, and in part with material supplied by the Station.

Two bulletins were issued during the year: No. 200, embodying the results of work done on the root-maggots in 1906, in such shape as to be available during the season of 1907, and No. 203 on "Some Household Pests," embodying the results of our observations, collections and correspondence during the past twenty years—nineteen of them in this Station. There has been no change in the staff of the office.

The meetings of the Association of Economic Entomologists were held during the winter of 1906-'07, in New York City, and were attended by all the members of the staff. The meetings of the Entomological Society of America in connection with the International Congress of Zoologists were held in Boston during mid-summer, and were attended by the Entomologist. The meetings of the various entomological societies in New York, Brooklyn, Newark and Philadelphia, were attended whenever possible, to keep in touch with all branches of the science and with all the advances and new knowledge communicated at such meetings.

Assistance has been given in other directions than those already mentioned, whenever asked for. A series of boxes was overhauled, and some were newly prepared for the exhibition made

by the New Jersey State Museum at Jamestown. A series of cases illustrating shade tree insects was prepared for the Forestry Exhibition at the Free Library in the city of Newark. A series of cases is in hand for the Newark Shade Tree Commission, and in all ways we have tried to co-operate with bodies and boards working toward the advancement of agriculture and arboriculture. To this end also, lectures have been given at meetings of farmers, fruit growers, improvement societies and other local bodies.

Our general collection is steadily increasing in extent and value, and much of it has been arranged and determined during the year. There is a large amount of material that is simply stored until opportunity is afforded to make it available in some way; either as part of the State Museum at Trenton or as a part of an Agricultural Museum, which is fast becoming a necessity as part of the outfit of the Station and of the courses in agriculture.

Mr. John A. Grossbeck has again assisted materially in the general work of the office and had general charge of the illustration and collection department of the office.

The correspondence of the office during the fiscal year extending from November 1st, 1906, to October 31st, 1907, covers 3,000 pages of letter book and represents about 4,000 individual communications.

ORCHARD INSECTS.

Orchards have, on the whole, suffered less from insect attack than in other recent years. All the usual pests were present to a greater or less extent and exacted toll; but there was less feeding on the leaves than usual, borers were not conspicuous and even the plum curculio seemed to be less troublesome than usual. There seemed materially less leaf hopper, especially on apple trees, and except in a few localities, plant lice were not conspicuous. But while conditions were good in general, there were some exceptions and especially in those that directly influence the crop while not causing injury to the tree itself.

Codling Moths.

Apple-worms, the larvæ of the codling moths, were far more than usually abundant during the past season, and caused a much greater money loss than fruit growers generally realize. There were a great many apples in New Jersey, taken altogether, and a great many of them were on trees in orchards where not much attention is paid to spraying, though they may be otherwise pretty well cared for. On such orchards this year more than 60 per cent. of the apples that remained on the trees until harvest were wormy, and at least half as many more dropped prematurely. No wormy apple is ever first grade, no matter what it may be in size, form and color, and with the prices as they ranged this fall, every apple was a distinctly valuable item.

In one large orchard of old trees not 20 per cent. of the fruit brought top prices, and there were few between first and culls. The owner had cull apples enough to get over two thousand dollars had they ranged as did his firsts, and the expenditure of less than 10 per cent. of that amount in spraying work would have secured him that sum.

Control of the codling moth in most parts of New Jersey is so easy and so certain that it speaks ill for the progressiveness of the fruit growers to find that they consent to lose anywhere from 40 to 60 per cent. of crop value rather than go to the trouble of spraying two or three times with Paris green or other arsenite.

Those in our State who are fruit growers primarily are strictly up to date in this matter, but there are many farmers, especially in the northern parts, who have from 100 to 300 trees, or sometimes only 50, which are allowed to care for themselves so far as insects are concerned, and these lower the percentage of our strictly first-class fruit.

Black Peach Aphis.

This species has been more than usually troublesome during the summer. Before the end of May complaints of trouble came from Cumberland county and the trouble extended to Hunterdon

county before the end of the season. Very little was seen of the leaf-form of the insect; the root-form was most destructive. Nevertheless, the unusual abundance of the specimens on the shoots first attracted attention to the insects and suggested the reason for the poor condition of the trees. Young trees as usual were affected most, and while older ones may have been equally infested they did not show it so much.

In Hunterdon county nursery trees were mainly affected, and quite a number of them were killed—one seedling block was so badly injured that it was plowed out.

This is the first time in several years that this species has been abundant enough to attract attention, and little or nothing was done to check it or prevent injury. In fact its presence was not realized until the injury was actually done in most cases, and then the growers did not know what measures to resort to. Practically, destructive applications are not very effective; but finely ground tobacco does exert a considerable influence for good. Worked into the soil beneath an infested tree it served to kill many of the lice, and as a fertilizer to stimulate the tree; the addition of a mixture of kainit and a little nitrate of soda will help materially by helping the resisting power of the plant life.

Fall Web Worm.

Beginning early in September the nests of the fall web-worm became conspicuous throughout the State, though not to the same extent everywhere. Wild cherry and many other trees along the roadside were defoliated, and in orchards where no spraying was done the trees were often a sight. Large apple trees were in some cases completely stripped, and pear trees were not infrequently altogether enveloped by the silken webs of the caterpillars. The difference between orchards neglected and orchards cared for was sharply brought out by this insect, and the effect of the defoliation will be to hasten the death of many an apple tree making a good fight against the San José scale and slow starvation in sod.

This great increase in fall was not unexpected when I noticed the unusual number of moths of the early brood. The spring

nests were not particularly abundant, but they seem to have matured all their inhabitants, and thus provided for a heavy fall supply. As the insects leave their nests to feed, there is no difficulty in reaching them with arsenical poisons; but they need a heavy dose, especially after they have become well grown.

San José Scale.

This has not been, on the whole, quite so destructive as in the few years last past. The weather conditions early in the season were decidedly against it, and breeding did not begin until July—in Northern New Jersey not until the month was well advanced. And this first brood was not heavy, even on badly infested trees. It seemed as if at the period of the maturing of the males a large percentage of these had been killed off by freezing weather, and many females, in consequence, never reproduced at all. Slow and scanty increase was the rule throughout the summer, and even in August neither larvæ nor young scales were at all abundant. But in September conditions had again become more favorable to the insects, and trees which a month before had appeared to be tolerably free, were swarming with larvæ and speckled with white sets—and it was not until the middle of that month that this heavy brood developed.

There is danger, therefore, that growers, especially of peach trees who found fruit and trees in good condition at harvest time, may not realize the importance of this late increase, and may find badly infested trees next spring where they expected to have them practically clean.

Nevertheless, the late start and slow increase during the summer has been of enormous benefit to the infested trees, and it has undoubtedly prevented spread and badly infested fruit.

It has also, incidentally, enabled a great many insecticide applications to make an unusually good showing early in the year. Up to the end of August the man who bored a hole in his tree and stuffed it with a patent compound was able to claim that his tree looked just as well as the one his neighbor sprayed with oil or lime and sulphur, and quite a number of persons have begun to talk hopefully of the natural disappearance of the scale.

I believe that conditions have improved materially, and that in many cases and under many conditions trees are resisting the scale much better than they have done in the past. But the scale is by no means disappearing, nor is the decrease in numbers the result of any increase in the natural enemies of the species. Plants and insects are slowly becoming adapted to each other; but the process is a slow one, and no grower with an orchard for which he has any regard can afford to wait for it.

A very large number of orchards was visited during the season by Mr. Dickerson and myself, and rather a close study was made of the conditions under which those trees grow that seem to resist the scale best. It has been no uncommon complaint by men who cultivate and spray that their trees suffered more than those of some of their neighbors who did neither, or certainly did not spray. And the complaint was justified to a great extent. There are apple orchards today in districts in which scale occurs everywhere and has occurred for ten years, in which no spraying has ever been done and from which crops have been taken each year. Scale is present in these orchards—plenty of it—and has been present for years; but it seems to do no more than hold its own, and the fruit is saleable. To be sure some of these trees are slowly dying now; but not from scale attack in all cases. In fact, in the case of apple orchards, many old trees are dying without enough scale on the entire tree to kill one branch; but the scale gets the credit for the death.

In a general way the more vigorous and sappy the tree growth, the more it is likely to suffer from scale attack. The bark is thin and jucy, the trees are smooth and nice, and the scale insects thrive as well as the tree until they poison and kill it. Good cultivation, good care and good feeding, especially in apple orchards, favor scale development and furnish a condition under which the horticulturist must fight continually for his orchard.

It is noteworthy that all the orchards that have stood for years without treatment have had little care and less food. The trees have made little growth each year other than fruit spurs, and the bark is hard and tough. Up to the very tips a hard skin is found, and on cutting this skin with a knife, the sap does not lie close to the surface and does not seem to be so abundant. The larval scales

are at a decided disadvantage, and on a great portion of the bark they simply cannot set at all; or if they do, they get mighty little nourishment. Orchards and single trees have stood in this condition for years; but, inevitably, that same combination that makes for resistance to the scale, starves out the tree and it slowly dies—like a number of orchards that I have seen and studied during recent years. Apple trees partly cared for, live longer. They get sufficient nourishment to keep them going, and they are toughened by conditions; and some varieties stand this method of treatment much better than others and become almost scale-proof. In almost every dying old orchard there are some varieties in much better condition than others, and even individual trees stand out against the destructive surroundings. Now these individual trees or varieties are not kept clean by parasites or other enemies that do not occur on the other trees. It is simply a toughening of the surface, and a sap condition that makes it so difficult for the insects to get a hold, that very few succeed in doing it. The same varieties in other conditions, favoring a ranker growth, are often as seriously injured as any others. I have met with no varieties that are uniformly exempt from scale attack.

We are not without examples of plum and peach trees badly infested by scales becoming almost completely freed. In almost all cases—not quite all—this freedom came after the trees had been abandoned and left to take care of themselves. They hardened up and the scale failed to maintaine itself further. By no means all abandoned trees free themselves from scale; most of them die; but enough of them live on to attract attention.

I have noted several times that where peach and plum trees have been de-horned or cut back to stumps, there was little or no scale for one, two or three years thereafter. All that was on the old tough bark simply died out, and left a practically clean tree.

I would not have it understood in any way that I advocate starving or neglecting trees to free them from scale attack. I simply wish to draw attention to the fact that thin-skinned, sappy, rapidly growing trees suffer more from scale attack, and to suggest that if hardiness of growth could be secured, even at the expense of rapidity, it might make control more easy.

As to the work done with the scale, that has been altogether in the direction of testing insectides and noting the effects of the various applications made throughout the state. Records of the insecticides results will be found under the appropriate headings; but in a general way much attention has been paid to indirect treatments, *i. e.*, acting through the circulation like carbolic acid and similar preparations.

Touching on this, and also in a way bearing on the question of hardening trees, the late Judge Woodbridge Strong always claimed that he had no trouble whatever in controlling the scale and that he never sprayed a tree. I have frequently visited his orchard at New Brunswick, and know positively that for ten years at least the scale has been in his trees—mostly pear. I know also that he never lost a tree from scale attack, and that while I could always find more or less of it, I never found any bad infestation. Not until the spring of 1907 did the Judge tell me what he did, and then it appeared that it was simply slaked lime applied early in the spring that was relied upon. The soil was drawn away from the trunk with a hoe to form a shallow dish about two to three feet in diameter, according to the size of the tree, and in this from two to three quarts of slaked lime reduced in a bucket of water was poured; quantity depending on the size of the tree.

The idea was that the tree would take up an excess of lime through the roots when there was plenty of it available, and that this excess of lime would harden the wood and make it unsuitable for scale consumption. The Judge never allowed rank growth on any trees, and many of them were actually dwarfed. They rarely made much growth in any one year, but they always bore heavily and remained free from scale.

Lime is present in considerable quantity in the normal wood growth, but whether it can be added to artificially, and whether, if it can be, this addition will add to the resisting power of the tree, are questions that must be tried out and answered by experiment.

Unfortunately the information came to me so late in the season that it could not be tried so as to secure best results this year. The liming should be done at or just before the tree is starting,

and the later in the season it is done the less certain are the results, so Judge Strong said.

I tried the lime on three trees in the Experiment Orchard—Nos. 18, 19 and 25—selected because they were the scaliest I had and those on which the scale usually bred most abundantly. The application was made May 18, and consisted of about 3 gallons to each tree. Up to the middle of September there was only the merest trace of scale on the trees, and on the 20th of that month only a scant scattring of new scales was to be seen. This was better than these trees had ever done before; but unfortunately every other tree in this series shared the same freedom, and it is absolutely impossible to claim for these trees that their clean condition was due to the application of the lime.

As a further test I put in a series of a dozen infested apple trees; the worst I could find in a condemned nursery block and five of these received, soon after they were set out, 1 quart of slaked lime reduced in half a bucket of water. On September 25th, there was only a slight scattering of new scales on these treated trees and no more on those that had not been treated. In other words, while all the lime-treated trees were in good condition, they were no better than those that had received no treatment.

A series of 12 similar infested apple trees was set out on the College Farm; all of these received lime applications at the rate of 1 quart slaked in one-half pail of water. The results were practically the same. Mr. Dickerson who made the applications and examinations reports under date of September 28, that every tree is more or less infested, and while the infestation is not destructive in any case, there is a very decided increase over last spring and as much as the season would warrant. A more full account of what was done with these trees appears elsewhere in the report.

The matter is of sufficient interest to warrant further experiments under orchard conditions if I can find some trees to serve as suitable subjects.

The observations made on the effects of carbolic acid applied to tree trunks have not demonstrated its effectiveness; but neither has it been proved that it may not under some conditions

be of some use. In another section of this Report that subject is presented at length.

In a general way the lime and sulphur combinations and the soluble oils have been relied upon by orchardists and both have been, on the whole, successful. As usual, there have been failures which it is simply impossible to explain, with both materials. The "Rex" lime and sulphur mixture has been tried in competition with the home-made mixture and with equally good results. Scalecide has been most generally used of the soluble oils, and has been very effective on the whole. Target brand scale destroyer has also been effective; but there has been much complaint that the emulsion was not stable and that when allowed to stand for a time it became unfit for use. A soluble oil prepared by the Thomsen Chemical Company of Baltimore was used to some extent, and with very good results. But as I have already indicated, almost everything made a good showing early in the season.

I have seen no reason to change my conclusion that the control of the scale is no longer a matter of securing an insecticide of sufficient killing power; it is a matter of application merely and mechanical in character. Either lime and sulphur or soluble oils will answer as killing agents, if they are made to reach the insects themselves.

THE EXPERIMENT ORCHARD.

A preliminary inspection was made on March 18th, to determine whether spring applications were needed by any of the trees. Mr. Dickerson made the examination, and from his report I decided to let things go for the season. Some peach borer was noted, and tree 44 was still dead; there was some blight on the Japan Golden Russet pears, and there were some dead twigs on the chestnut. Otherwise matters were not bad. As the bark beetles had obtained a foothold in tree No. 44 I had it cut out and burned April 15th.

May 1st, I resumed the occupancy of my place and began a systematic trimming out and shaping up so far as conditions permitted.

May 18th, trees 18, 19 and 25 received an application of freshly slaked lime around the base. A basin 6–8 inches deep was hoed around each tree, and into each I poured 2 quarts of slaked lime reduced to a bucket holding about 3 gallons.

May 25th, sprayed trees 29, 47 and 48 with the Vreeland arsenate of lead, 2½ pounds in 25 gallons of water. The application was primarily a test of the insecticide as to its action on foliage and was made with a Deming Pump, and an extension gas-pipe rod tipped with a single "Friend" nozzle. This outfit proved so satisfactory that it was used throughout the season. The single Friend nozzle does the work of a doublet or even a triplet Vermorel, and proved the best all-around nozzle that I have ever used. It rained during the night of the 25th, more or less during the 26th, quite heavily during the night of the 26th and very heavily, indeed, on the 27th.

May 28th, picked off all the visible fruit on trees 18 and 19. Fully 90 per cent. of it was infested by the pear midge and I preferred to destroy everything for this year so as to prevent the maturing of the adults. On the 29th made another application of Vreeland arsenate of lead, 2½ pounds to 40 gallons of water on trees 38 and 43, and on the 30th treated tree 29 in the same way, partly duplicating also the application on tree 38.

May 30th, also, I made up a combination of a 6 lb. bag of "Target brand quick Bordeaux" and 2 pounds of "Disparene" in 40 gallons of water and applied to trees 1, 2, 3, 8, 43 and 48. Tree 47 received a partial dose when spraying 48, and tree 42 got an incidental dose of arsenate of lead while spraying 38. Then reduced the remaining mixture to half strength, and sprayed trees 18, 19, 23, 24 and 33. During the night of the 1st a heavy storm began and continued throughout June 2d, and when that was over there was very little appearance of spray remaining.

June 12th, prepared another 40-gallon tank of the "Target brand quick Bordeaux" with 2 pounds of Target brand arsenate of lead, and sprayed trees 1, 2, 3, 8, 19, 20, 29, 30, 33, 38 and 48.

July 23d, another lot of the same combination was prepared, using the Vreeland arsenate of lead and sprayed all the grapes and the large apple trees—2, 8, 29, 30 and 38. This application stuck

for the balance of the season and no more general sprayings were made.

The trees, as a whole, remained remarkably free from scale throughout the year. The last applications of an insecticide as against the scale were made in the late fall of 1905, and these cleaned the trees very well. They seem now to have reached the stage where the scale has little or no further effect on them. There is probably not a tree on which there are not some specimens; but they certainly have not increased and multiplied according to their opportunities. The season of 1907 was not a good one for the scale; but even this season it multiplied in late summer, while 1906 was certainly not a bad one for it. Even the most susceptible of the trees, those that have always been infested and have required continued and persistent treatment to prevent injury, have now stood two full seasons without harm and are not scaly enough to induce me to use anything during the current winter.

Tree 1—Mariana Plum. Was in full bloom—a mass of white flowers—on May 3d. As no pruning at all was done in 1906, it is now a tangled mass of interlacing and interfering twigs. May 25th the tree was out of bloom and had made a very heavy set of fruit, out of which not twenty examples matured, eventually.

May 30th, sprayed with the "Target brand Bordeaux" and "Disparene," covering thoroughly. June 12th, duplicated the application, Target brand arsenate of lead replacing the "Disparene." This spraying remained visible until well along in July. In early August a good many leaves turned yellow and dropped, and shot-hole fungus became noticeable. On the 18th the few ripe fruits were gathered, all free from scale. There was little change afterward. The foliage remained somewhat ragged; but no more of it fell, and on October 30th, after a series of heavy frosts, the tree was yet full of green leaves, while the new wood was clean, smooth and free from scale.

Tree 2—Yellow Transparent Apple. The tree started in good shape, a moderate bloom showing in early May and disappearing about the 20th, leaving a small set of fruit. May 3d, a scattering scale infestation was noted on the newer wood; but no live examples were found on the old wood.

May 20th, sprayed with the Bordeaux mixture and "Disparene," and on June 12th this application was duplicated; the "Target brand" arsenate of lead replacing the "Disparene." This application stuck until early July, and on the 23d of that month was again duplicated; Vreeland arsenate of lead serving as the insecticide in this instance. The fruit developed slowly and some of the apples turned rusty on one side and began to crack in July. By August 18th, all the fruit had been removed, about 2 baskets in all, and there was not a scale on any specimen. There was at that time a great deal of yellow foliage and some of that was dropping; otherwise the tree was in good condition and there was much less leaf-hopper injury than usual.

September 22d, quite a bit of the foliage had dropped and the work of the leaf-hopper was more obvious. The loss of foliage has been toward the outside of the tree and the centre looks much better. Some of the shoots had 2 or 3 leaves at base, then a blank space and finally a little tuft at tip. Moving larvæ and recent sets were then visible on most of the older shoots; but there had been no extension on the new wood.

By October 30th two-thirds of the foliage was off, and the scale was apparently no worse than at previous accounts.

I have been inclined to charge the Bordeaux mixture with some of the injury to foliage, and am not sure that it was not to some degree in fault, though there was none of the characteristic spotting.

Tree 3—Black Tartarian Cherry. Was in full bloom and in fine condition May 3d, but made a very irregular set of fruit. May 25th, curculio marks became obvious, and on May 30th sprayed with full-strength Target brand Bordeaux and "Disparene." The application was duplicated June 12th, using Target brand arsenate of lead instead of "Disparene." July 4th the fruit remaining was ready to pick. The robins and the children had kept down all tendency to an over-burden of mature fruit, and what there was was of good quality.

August 18th the tree did not look so well as usual; there was considerable yellow in the foliage and quite a little dropping, a few shoots showing entirely bare. This dropping continued until well along in September, but then stopped, and on October 30th

it had scarcely fewer leaves than in September. Several colonies of web-worms started during September, but never got beyond the first leaf or two. Apparently there yet remained arsenate enough from the June application to kill all the young caterpillars.

Tree 7—Champion Peach. This is a ragged specimen which bore a good crop in 1906; was affected by rot that killed off some shoots, and was also broken. No cutting was done in 1907, and only the dead wood was cut out in early May. On the 3d of that month it was out in full bloom, and on the 25th had made a heavy set of fruit. Most of this dropped, but a very decent little lot came to maturity late in August and early September. About the middle of August the foliage of this tree also began to turn yellow, and some of it dropped. As no spraying of any kind had been done here there was nothing to account for this condition.

September 22d fully half the tree was dead, and I had the entire top cut out. There was no scale on the new shoots and very little elsewhere, with not a larva or recent set to be found. On October 30th the foliage was off or ready to drop, and on the live wood there was a heavy set of fruit buds. It was determined to allow the tree to stand another season and to shape it up as best could be done.

Tree 8—Baldwin Apple. This was set and has figured in previous reports as "Grimes Golden;" but when it fruited in 1905 it was recognized as something altogether different, and like No. 38. The fruit was not seen in 1906, but this year enough of it was allowed to ripen to make certain that it is really a Baldwin, which apparently does not reach its best development in my red shale.

The tree started well, but had very few blossoms and made only a light set of fruit. The old bark of the trunk was peeling off in flakes, exposing a clean, fresh surface below it. Only the merest trace of scale could be found.

May 30th sprayed with Target brand Bordeaux and "Disparene," full strength. June 12th the application was repeated, Target brand arsenate being used in place of "Disparene," and this application remained obvious for a month. July 23d made

yet another application, using this time the Vreeland arsenate of lead in combination with Target brand Bordeaux.

August 18th no scale was observable on the fruit, and there was little appearance of the ordinary fungus troubles, but there was a great deal of yellow foliage and many leaves had dropped. Late in September a few scales became visible on the fruit, and on the 29th of that month, as the premises were left untenanted for a few days, all the fruit was taken off to remove temptation to trespass, although it was not in real good condition to pick.

October 30th the tree was in excellent condition, foliage about half gone, the new shoots of satisfactory length, clean and free from scale.

Tree 15—Japan Golden Russet Pear. As this tree was not cut at all in 1906 it outgrew its trellised limits, extended much higher than I had heretofore allowed it to go, and had developed shoots directly away from the trellis. Some of the older branches had died, and when these were cut out not much of the original shaping remained. The supports were allowed to remain during the summer, but were removed in the fall. There was only a small bloom and a small set of fruit, which, however, developed well and was larger, cleaner and better than ever before. October 30th the last of the fruit was taken off; the foliage was yet almost intact, and there was no obvious scale on the new wood. This tree received no treatments of any kind.

Tree 16—Japan Golden Russet Pear. The record is in general that of the preceding, except that it is a smaller and poorer tree throughout and more hit by blight. Late in September a brood of scale larvæ and recent sets was observed on the old wood, but there was no general increase, and on October 30th, when the foliage was yet almost complete, the new wood was scarcely infested.

Tree 17 Trellised Peach. On May 3d this was one mass of large, showy blossoms. As there had been no cutting in 1906 there was a mass of long, thin whips, absolutely incapable of carrying a crop; but as I was curious to see what the fruit was like I allowed it to remain until late in September; then, as all the fruit had dried up or rotted and most of the foliage was already

off, I cut it out. Scale appeared on this tree in July, earlier than elsewhere among the trees; but there was no freer breeding, and in September the insects were no more conspicuous than in July.

Tree 18—Vermont Beauty Pear. This tree had been injured by blight in 1906, and there was a little in 1907 which was cut out when noted. The branches extend into the grape trellis, and the tree was invaded by the vine growth last year, so that, altogether, it needed considerable shaping up. It blossomed well and set a good crop of fruit, but, as 90 per cent. of it, at least, was infested by the larvæ of the pear midge, I had the entire set removed May 27th. One fruit escaped and ripened in late September, clean, nice, and free from scale.

The tree was sprayed with half-strength Target brand Bordeaux and "Disparene" May 30th, and received no other applications during the season. The yellow foliage and dropping of leaves manifested itself in mid-August here also, and growth had already stopped at that time.

On October 30th, very little foliage remained, the tree appeared to be otherwise in very good condition and scale conditions were satisfactory. On May 18th this tree had received 2 quarts of lime in 3 gallons of water, poured around the base of the tree.

Tree 19—Vermont Beauty Pear. In general way this tree is much like the preceding but poorer throughout. This fruit also was removed May 28th, and here also one example escaped to ripen in late September. The same lime application was made May 18th, and the same spraying with one-half strength Bordeaux and arsenate of lead was made on May 30th. On June 12th, however, this tree received an additional application of full-strength Target brand Bordeaux and arsenate of lead.

Scale conditions were worse than on tree 18. Breeding began early in July and a considerable number of recent sets were observed on the 4th of that month. Again, on September 22d larvæ and recent sets were found; but on October 30th matters were not at all bad. Most of the foliage was then gone; but there was little scale observable on the new wood and none of the old wood was at all badly infested.

Tree 20—Meech Quince. This tree made a slow start, bloomed sparsely and matured a small crop of fruit. There had been some blight in 1906, and there was a little in 1907 which was cut out as it manifested itself.

June 12th, sprayed with the Target brand Bordeaux and arsenate of lead, full strength, and this application was visible most of the season. There was very little scale at any time and no larvæ or recent sets were seen on the formal examinations.

October 30th, the tree was yet in full foliage and the crop was ready to pick: about two dozen specimens ranging from fine, smooth, good sized examples to little bruised runts. As to foliage conditions this remained in rather better shape than any other tree on the place.

Tree 23—Greensborough Peach. This is one of the lanky growing trees that need constant cutting back to get stout. No cutting was done in 1906, and in consequence there are only thin whips which early in May were set with large showy blossoms. It made only a moderate set which stuck well and supplied peaches from the beginning to the middle of August—a few each day. The fruit was of good size, fine shape, fair flavor and free from scale.

May 30th, it received a light and somewhat incomplete application of the half-strength Bordeaux with "Disparene." The foliage was rather small throughout the season and not of especially good color; but there was not much drop and it stuck well until the October frosts. On October 30th, it was almost all off and there was a good setting of fruit buds.

As to scale, there was not much of it at any time. On September 22d there was a small scattering of larvæ and recent scales, but when the last examination was made in October very few specimens were obvious on the new wood.

Tree 24—Greensborough Peach. This is a badly-placed tree and does not get much sunshine. In consequence it grows thin and lanky, the foliage poor in color and widely spaced and the trunk slender, out of proportion to the top. It was full of small dead twigs in early May when it blossomed out, and it made only a small set of fruit, most of which disappeared before it ripened.

Only a few good examples were picked during the early days of August.

May 30th, applied the one-half strength Bordeaux and "Disparene" lightly and not very thoroughly. The foliage became ragged and full of holes in July and August and dropped early. On October 30th, nothing remained; but there was a full set of fruit buds for next year.

Not until September 22d were larvæ and recent set scales noticed and even these seemed to have largely disappeared in late October.

Tree 25—Apricot. During the early warm spell this tree made a start that brought the blossom buds to the almost open stage, and then the ensuing frosts killed them off. Apparently a considerable brood of scales set on some of the bent branches in the shelter of the trellis, and, partly as the result of this scale injury and partly from the distortion caused, these shoots died off. Quite a bit of reshaping of the tree was required, however, and the trellis was abandoned. The fan shape, making it useful as a screen, was preserved by cutting.

On May 3d my note was: "There is plently of live scale to all appearance; but the long shoots of last year's growth are comparatively free." On May 18th, applied 2 quarts of lime to the surface around the trunk, in a 3-gallon pail. The tree made its usual vigorous growth, and in late September when larvæ and recently set scales were quite generally found, none could be seen here. On October 30th, it was yet in full foliage and apparently clean and free from live scale.

Tree 26—Nectarine. This tree was late in starting, blossomed very sparingly and matured only half a dozen very inferior fruits in early October. It grew well after it had started, however, and held its foliage as to color and condition throughout the season. On October 30th there had been scarcely any drop, and it yet appeared green and fresh.

As to scale there was little of it noticeable at any time during the year and at no period were there any larvæ or recent sets apparent. This tree had no treatment of any kind since October, 1905, during which year it was badly infested. Traces of that

infestation are still obvious in the rough scaly bark on the injured wood.

Tree 29—Gravenstein Apple. This is an excellent tree in all senses of the word: a little too much wood; but shapely and sturdy in development. It was a mass of flowers during the early days of May and by the 25th nearly all the flowers were off, some of the fruits were already well developed and in good condition to spray. Applied the Vreeland arsenate of lead, 2½ pounds in 25 gallons of water and covered thoroughly from all sides.

June 12th, sprayed with the full-strength Target brand Bordeaux and arsenate of lead, and on July 23d duplicated this application substituting Vreeland arsenate of lead for the Target brand.

Early in August quite a percentage of the foliage began to turn yellow and some dropped. The fruit was on the whole very good, all free from scale and very little of it wormy—in strong contrast with the record for 1906. Ripening began about the 10th, and a heavy wind brought down nearly a basket which were fit to use. By the 1st of September most of the fruit was ripe and a half barrel of it was picked off. Altogether, about a barrel of very good, clean apples came from this tree. But while the general condition of the tree was good the foliage was as thin as it should ordinarily be in early October. It grew no worse, however, and on October 30th about two-thirds of the leaves were off. As to scale very little was seen of it until September 22d, when larvæ as well as recent sets were found on the older wood where they apparently did nothing more, later.

Tree 30—Grimes Golden Pippin. This is another nice healthy tree, kept low and rather bushy in character; but vigorous and with more wood than it needs for its best interests. It blossomed sparingly and set a small crop of fruit, much of which dropped. During late June and early July the plum curculio attacked it in force, and many of the apples became distorted and knotty. Most of the fruit, about one bushel, was taken off September 29th, not because it was in the best condition, but because it looked too attractive to be left much longer, and I knew I could ripen it in store. There was no scale on any of it, and very little codling moth. In 1906 Mr. Dickerson's record was, on August 8th, "no

scale on fruit, which is nearly all wormy." The contrast is all to be credited to the spraying that was done.

June 12th, sprayed with the full-strength Target brand Bordeaux and arsenate of lead, and on July 23d repeated this application, substituting Vreeland for Target brand arsenate.

August 18th, some of the leaves had turned yellow and a few had dropped; but there was very little all told, and on October 30th it was yet in almost full leaf. At that time the few remaining fruits were taken off—now in prime condition.

Scale breeding was noticed on this tree, July 4th; but later it seemed to be much less in evidence, and on September 22d, when there was a general breeding, less was seen than in July. Very little was seen on the new growth in October; but there may be quite a lot of living specimens on the older wood beyond the range of easy examination.

Tree 31—German Prune. This tree made a good even start early in May; but blossomed sparingly and set fruit lightly; most of this falling victim to the plum curculio. The few that were left ripened in late September and were excellent.

No applications of any kind seem to have been made on this tree, and none seem to have been needed. Scale breeding was noted July 4th, and again on September 22d moving larvæ and recent sets were observed; in each case in small numbers. On October 30th only about one-fourth of the foliage was off, and while there was a scattering of scale noticeable on the new wood, there was not enough to make treatment seem necessary.

Tree 32—Mountain Rose Peach. A very nice little tree with long thin shoots. It blossomed early in May and made a very heavy set of fruit, most of which either dropped, shriveled or wilted, leaving only a small crop that reached maturity in late August; way behind the usual period.

This tree was not sprayed at all and could not well have received more than a small sprinkling from the spray meant for other trees; nevertheless, in early July much of the foliage turned yellow and dropped; more of it developed purplish spots with yellow borders, and most of this trouble was in the center of the tree. After midsummer matters improved somewhat, and on

October 30th the leaves were not yet all off, though ready to drop at a touch.

At no time during the season was any scale-breeding observed.

Tree 33—Dwarf Duchesse Pear. This is a tree that has never been really good for anything. It has served to test a great variety of insecticides and has been more or less scale-infected since it was put out. From one cause or another it has become of such an unfortunate shape that it was difficult to do anything with it. It had a few blossom clusters in May, but set no fruits. On May 30th it received an application of one-half strength Target brand Bordeaux and "Disparene," and on June 12th, a full strength dose of the same with Target brand arsenate of lead.

The foliage remained in good condition throughout the season, and while developing scale was noticed July 4th and September 22d, there was not enough to cause trouble at any time. Nevertheless, the general condition of the tree was such that I cut it down November 1st, while yet in full foliage.

Tree 35—Japanese Walnut. This tree continued to grow as rankly as usual, blossomed heavily, but set no nuts. Several broods of the black *Datana* developed during the season, and the caterpillars were mostly killed off when they came down and settled on the trunk in characteristic masses. Early in September I noted that web-worms were beginning to develop all over the tree, and as it had had no applications of arsenites at any time during the season, I had it sprayed with arsenate of lead (Vreeland) at the rate of 2 pounds in 25 gallons of water, on September 16th. A week later the larvæ were dead or had scattered, and the nests disintegrated without further increase in size.

Ocober 30th, the tree was completely bare and at no time during the season were scale larvæ or recent scales noted on it.

Tree 38—Baldwin Apple. An excellent, vigorous tree which made very long shoots in 1906, and came into bloom so gradually as to create the impression that the crop could not be a very heavy one. May 25th, all stages from blossoms to well-set fruits were present, and I sprayed from one side only, with the Vreeland arsenate of lead, 2½ pounds to 25 gallons of water. On the 29th I made a more complete application with 2½ pounds in 40 gallons of water, and on the 30th, as there seemed some

shoots at the top of the tree which were not hit, I sprayed once more to hit just those places.

June 12th, sprayed with full-strength Target brand Bordeaux and arsenate of lead, and drenched all save the extreme tips which I could not reach because of the rather high wind. July 23d, this application was duplicated, using this time the Vreeland arsenate of lead. A good crop of very nice characteristic fruit developed, and on September 29th, on the eve of a few days' absence from town all were taken off—not ripe but usable; in all about a barrel of nice sound fruit with the merest trace of codling moth and with some scale on about 20 per cent. of the specimens; sometimes only a single example, sometimes several. In no case were there more than a few and no fruit could have been by any stretch of imagination be considered as badly infested.

About the middle of August there was some yellowing of foliage and some leaves dropped; but not enough to affect the general appearance of the tree and on November 2d, there was little of it down.

Scale was found on the spring examination and always subsequently some living examples could be found; but it was not until September that breeding became obvious and then nearly everything was on the fruit. The marks there were easily observable: on the twigs it was almost impossible to find the insects.

Tree 42—Elberta Peach. A lanky little tree that has not made much growth and is poorly situated, close to 38. It made a nice start in early May, blossomed well and set some fruit, all of which dropped before it was ripe. It received quite a dose of the applications of arsenate of lead and of the Bordeaux mixture that was applied on tree 38, and the result was practical defoliation. Late in August it was mostly thin shoots, with little tufts of leaves at tips. On November 2d the leaves were nearly all off, and on the side next to tree 38 several twigs and one branch were dead.

As to scale, there was none seen at any time during the season.

Tree 43—Early Richmond Cherry. This is the same old straggling tree: not much increased in size nor in appearance. It blossomed in early May, made a fair set, and matured a small

crop of very poor fruit, most of which was taken by the robins without dispute by the children. May 29th, sprayed thoroughly with the Vreeland arsenate of lead, 2½ pounds in 40 gallons of water, and this application was incidentally duplicated next day When tree 38 received its coverings of Bordeaux mixture this tree was almost as fully coated by the waste and blown spray.

Quite a bit of foliage turned yellow and dropped in July; but after midsummer there appeared to be a recovery and in September and October the tree looked better than ever before. On November 2d very little foliage had dropped, although it is all discolored.

There was little scale on this tree at any time during the season and only in late September was there any appearance of breeding

Tree 44—Elberta Peach. This tree died during the summer of 1906, and was taken out April 15th because it had been invaded by the fruit-bark beetle.

Tree 46—Japanese Chestnut. This tree grows slowly and does little more than maintain itself. Apparently neither the soil nor the surroundings suit it and it is held merely as an example of this kind of tree for purposes of such experiment as may be needed. It made a late start in spring and set a few burrs which were opened November 2d and proved to be empty or with undeveloped nuts. Red mites and plant lice sapped the foliage which, however, held on throughout the season. It has never been scaly.

Tree 47—Greensborough Peach. This tree was over-burdened with fruits in 1906, some of the branches broke down under the load and the new shoots were allowed to develope as they would. It is therefore a poorly formed, unsatisfactory tree. The bloom was full, the set heavy and from it all developed a very decent crop of very fine fruit which lasted from about the beginning to a little after the middle of August.

To test the effects of the material on foliage I sprayed with the Vreeland arsenate of lead, 1 pound in 10 gallons of water, on May 25th. On May 30th, it received a partial dose of full-strength Target brand Bordeaux while tree 48 was sprayed. A little foliage yellowed and dropped in early July, but not much,

nor enough to affect the appearance of the tree. On November 1st, all the foliage was off and a heavy set of fruit buds had been made. At no time during the season was there more than a trace of scale and there was no breeding noted at any period.

Tree 48—Black Tartarian Cherry. Started out satisfactorily in spring and bloomed well, but was injured by frost, and there was only a small, irregular set of fruit. Most of this the robins secured, and the balance came off about July 4th.

May 25th, applied a thorough coat of the Vreeland arsenate of lead, 1 pound in 10 gallons of water. On the 30th applied a heavy dose of Target brand Bordeaux and "Disparene," full strength, so that the tree looked blue when dry. June 12th, this application was repeated, using Target brand arsenate in place of "Disparene." In early July some leaves began to turn yellow and dropped, and up to the middle of August this continued. After that time matters improved, and on November 1st the tree was yet in almost full foliage and in general good condition.

This tree was never scale-infested and is now free from this pest. In September a number of colonies of web-worms made a start, but never got further than the first leaf or two. It is interesting to note, in this connection, that the only tree on which these insects got a foothold is 35, which received no arsenical applications early in the season.

NURSERY TREE EXPERIMENT.

Out of an infested nursery block twenty-four of the worst infested trees were selected by Mr. Dickerson; twelve of them to be set out on the College Farm, twelve of them to be set out in my own garden. These trees were delivered on May 2d, and planted on May 3d. The trees on the College Farm were heeled in at once—those sent to my house were left without notice to me and exposed to the sun and air.

May 3d, I set nine of the trees that were in good condition, rejecting three that I believed would not grow. The varieties were Mt. Pearmain, Rhode Island Greening, York Imperial, Newtown Pippin and Ben Davis. All had started growth, the York Im-

perial less than the others; all were cut back moderately as t top and were set without root pruning, into holes large enough t take them easily. The soil was well packed around the roots ar half a bucket of water was used to wash the soil into contact wi the fine rootlets. As they were intended for temporary exper ment only they were planted in two rows four feet apart and 5 fe apart in the row.

On the same day the trees were set out on the farm by M Dickerson and Mr. Blake. These trees were set eight feet apa in a single row, were pruned root and top and were firmed in place with water. There were four trees each of York Imperia Mt. Pearmain and Newtown Pippin.

May 16th, all the trees on the farm had made a start and aroun each was poured 1 quart of lime slacked in half a bucket of wate

May 18th, one Rhode Island Greening, and three York In perial trees in my garden were treated in the same way. Th soil was hoed away a little so as to form a basin, and the hot lim was kept from actual contact with the trunk. On the farm th field in which the trees were set was cultivated, and the trees re ceived the benefit of that treatment. In my garden they wer left undisturbed and received no care of any kind.

July 4th, all of my trees had taken hold and were growin except the single Ben Davis. The three rejected trees being als Ben Davis, this variety was left without representation. On som of the others the scale had just made a start, but on four of the there was not a sign of young as yet.

About this time two Mt. Pearmain and two Rhode Islan Greenings were painted with "Avenarius Carbolineum," a ma terial for which it was claimed, as it was for carbolic acid, that would enter into the circulation and would thus kill the scales se ting on the tree.

July 10th, the farm trees were growing well and were all i good shape except that they were more or less infested with plan lice. The scale had begun to breed on all the trees and recent se were found in small numbers. There was no bad infestation i any case and only recent sets were noted; breeding had, evidentl just begun.

July 24th, Mr. Dickerson applied on two trees of each variety—York Imperial, Mt. Pearmain and Newtown Pippin, a band of carbolic acid, 60 per cent. The band was begun about a foot from the ground and was about a foot in width up and down the trunk. A good surface coating was applied but there was no attempt to saturate. At this time breeding had ceased except on one tree, and scales were generally in the black stage.

I kept a general lookout on the trees in my garden, keeping off caterpillars, etc., but not interfering with the plant lice, which curled the tips and soiled the foliage to some extent. All the trees except the Ben Davis took hold well and kept in pretty fair condition, although none of them made very much growth. This is due very largely to the character of the soil—red shale, without fertilizer of any kind, and partly, no doubt, to the fact that there was no cultivation, allowing a growth of grass and weeds about the base.

September 20th, there was little to choose between the trees so far as scale infestation was concerned. None of them were bad; but none of them were free. There had been just about what might have been expected from an infested nursery tree in a season that was so bad for the scale as this just past. The mid-September brood was the heaviest of the year and was about the same on all the trees. As between the limed trees and those with the "Avenarius carbolineum" there was nothing to choose. One set was as little and as much infested as the other and neither had harmed or injured the trees in the least. Results are absolutely negative.

As to the farm trees, these were examined by Mr. Dickerson, September 28th, and every tree was found scaly. None of the trees were very bad and on some the infestation was very slight. As all the trees had the lime application, differences in the amount of scale could not be due to differences in application unless the carbolic acid trees were uniformly different—which they were not.

The notes on the trees painted with carbolic acid are of most interest. Two of the trees are York Imperial. On both, there were many sets on the trunk, and some of them were on the very bark on which the acid was applied, so that the actual presence of the acid in the outer bark layer does not prevent the scale from

setting on it. On both trees the acid-treated bark had cracked on the northwest side, and for a space was dead, as were the shoots that had come from that area. While the upper part of the tree appeared to be still in good condition, a number of shoots were starting below the acid-treated area or at the surface of the ground.

One of the Mt. Pearmain trees was much like the two above described, and on this also, shoots were starting at the surface of the ground. The second was in much worse shape. Here the acid penetrated the bark on all sides and the top was dying because the girdling was almost complete. There was plenty of scale; more than on almost any other tree, yet not enough to cause any actual injury. New shoots had started from four points below the acid ring so that there is plenty of life in the root.

The two Newtown Pippins are apparently uninjured by the acid and both have done well. One of them has quite a setting of scale on the trunk, over the acid as well as on the untreated portion, while the other has only a sprinkling of scales scattered over the tree.

As to all these materials, it may be said that the applications were made too late, and that may be so. It proves, however, that they are not reliable when it comes to securing prompt action, and that despite either of them, a tree might be completely destroyed by the insects. The acid also is dangerous to young trees.

INSECTS ON SHADE AND OTHER TREES.

Interest in shade trees continues to increase in cities, towns and villages, and the number of organizations engaged in active work continues to increase. Morristown has been added to the number of those with organized commissions, and systematic efforts to preserve and improve the many fine trees of that city have been started.

On the whole city trees have suffered comparatively little from insect pests, although all the commissions and other organizations have an abundance of trouble to look after. The cottony and woolly scales on maples have been eliminated by natural enemies,

and it is doubtful whether either will ever again reach the same abundance in the municipalities with organized shade-tree commissions. The abnormal increase of the bag-worm is the most interesting feature of the year in this connection.

Elm Leaf Beetle.

Very little was seen of this insect early in the season and it was, in some cases, hastily decided that there would be no trouble from it during the summer. I was of much that same opinion myself from collections made at New Brunswick, and advised that it was not necessary to spray the trees on the College Campus. As to this the event justified my advice; very few larvæ were found later on these trees, but as for the rest of the city there was more injury than there has been for years past. And that seems to have been the experience pretty generally in those sections where the insect is troublesome. Comparatively few hibernating beetles were obvious, but there was a heavy oviposition and resulting larval brood.

The College elms were sprayed in 1906, and the difference in their favor during the present season was enormous. There were few adults early in the season and not enough larvæ afterward to cause the dropping of even a single leaf. Elsewhere in the town the foliage on every susceptible tree was so completely scraped that in September the foliage was dry and beginning to drop.

In other cities the small number of surviving beetles noted also gave rise to a false sense of security, which was rudely shaken when the developing larvæ began to make their work obvious. Not for many years has so heavy a brood matured as reached the adult condition during the season of 1907, and the outlook is for serious trouble in 1908, unless some adverse winter condition reduces the number of hibernating adults.

The condition in New Jersey was by no means different from that in other localities. In Massachusetts I found the insects even more numerous and the injury decidedly more marked. In Connecticut conditions were no better, and it would seem as if the

general climatic conditions between September, 1906, and May, 1907, were ideal from the standpoint of this species.

Arsenate of lead was quite generally relied upon to keep the insects down, and on the whole it did good work where properly applied.

The Bag-Worm.

This insect has been unusually abundant and destructive on shade and ornamental trees and shrubs in several sections—chiefly in the Delaware river counties. It has been more than normally troublesome everywhere, but in parts of Camden, Burlington and Gloucester counties it has become a genuine pest. Shade trees of almost all kinds suffered to some extent, the Norway Maple most of all, and, as usual, the Arbor Vitæ hedges and other conifers were among those most seriously affected. In some nurseries, indeed, the most active measures were required to prevent loss.

Just what caused this unusual abundance it is impossible to say with certainty, but that there seems to be no dearth of parasites is indicated by the breeding experiments carried on in the laboratory.

I noted large numbers of the young caterpillars early in the season on some orchard trees near New Brunswick, but the ordinary spraying operations sufficed to control these and little trouble occurred where matters were properly looked after. Apple and cherry among these trees were the greatest sufferers.

There is no difficulty in controlling this insect where proper measures are taken in time. A single application of arsenate of lead when the young begin feeding will serve to free the trees so completely that nothing more will be seen of them later in the season. As is the case with many other caterpillars, advanced growth results in greater resistance to poisons, and an application that will promptly kill the worms in the early stages will prove comparatively ineffective against caterpillars more than half grown. When they are almost ready for the change, in late August and early September, further applications are almost useless.

Some injury was done to Arborvitæ and other evergreens by spraying with Paris green; but with arsenate of lead good results were obtained.

For an early application soon after the worms have hatched, arsenate of lead 1 pound in 25 gallons of water or 1 pound of Paris green in 125 gallons of water, is ample. For the half-grown caterpillars 1 pound of arsenate of lead to 10 gallons of water will be required, while of Paris green 1 pound in 100 gallons will be effective.

On shrubs, hedges and small trees, collecting the bags in winter is still recommended as an effective measure.

To gain some idea of the relative proportions of the sexes and the percentage of parasitism, collections were made near New Brunswick and Mr. Grossbeck was put in charge of the work.

The specimens gathered were presumed to be fully grown and were not fed after they were placed in the cages. Altogether 1,335 bags were brought in during September and males and parasites began issuing soon afterward and continued to issue until late in October. The first male adult occurred September 16th, the last on October 15th. The parasite is a species very like and probably the common *Pimpla conquisitor* and of this the first example appeared September 11th and the last October 22d.

Three hundred and ninety-nine (399) specimens died in either the larval or pupal stage and some of these undoubtedly were specimens not quite full grown when collected and which were really starved. About twenty of these were males that died after the adult was actually formed and had not strength enough to get out of the pupal shell.

Two hundred and ninety-six bags produced male moths, and 347 contained fully developed females, most of which were never fertilized and died with undeveloped ova.

One hundred and seventy-seven (177) parasites emerged from male pupæ and 108 emerged from female pupæ, this excess of parasites in the males accounting for the greater number of female adults obtained. The eight remaining bags were infested by other parasites which apparently do not mature in fall. As against 643 bags that produced adults, there were 293 that pro-

duced parasites; not a large percentage of parasitism in a species that has the reproductive powers of the bag-worm.

In other localities the percentage of parasitism was greater: two correspondents, on Long Island, each gathered over two hundred bags and failed to secure a single adult male. Every specimen seemed to have been parasitized and the parasite seems to have been this same *Pimpla conquisitor*.

The Gypsy Moth.

Twice during the summer of 1907, I visited Boston and vicinity to watch the work done against the Gypsy Moth, and once I sent Mr. John A. Grossbeck to look over the territory.

The first of my visits was during the week of June 24–29 and was at the invitation of Mr. A. H. Kirkland to look over field conditions and at the methods of handling the parasite imported from foreign countries. The second of my visits was during the week of August 19–23, during the meeting of the International Zoological Congress and of the Entomological Society of America.

Both the Gypsy and Brown-tail moths are spreading; of that there is no doubt. The brown-tail moth has extended northward and eastward and has reached Nova Scotia. The Gypsy moth is following more slowly, but it has established colonies in Maine and New Hampshire to the north and in Rhode Island and Connecticut to the south and west. In the latter States its distribution is limited and effective means of control are employed. It is believed that there will be no spread from these points at present. In New Hampshire, Professor E. Dwight Sanderson, the Director of the Experiment Station, has the matter well in hand, and with the assistance of the Entomological Division of the United States Department of Agriculture is locating and trying to limit the colonies. With the work in Maine I am not at present familiar.

In Massachusetts the effort to exterminate has been abandoned. The brown-tail moth has spread so far and has such powers of spreading that no attempt to limit it stands much chance of success at present. The attempt to limit the spread of the Gypsy

Moth is more hopeful, and in this the United States Government is furnishing aid.

Over a million dollars have been appropriated by the State of Massachusetts for this work and compulsory legislation secures the co-operation of local municipalities. The result is a campaign unparalleled in extent, looking to the destruction of the insects not only in the towns and villages but in the fields, orchards and woodlands!

To the United States Department of Agriculture force has fallen the task of controlling the condition of some of the main roads and lines of travel to prevent the carrying away of caterpillars by vehicles, and especially automobiles.

But the most interesting feature of the work is the importation of parasites of both Gypsy and Brown-tail moths in simply enormous numbers. Dr. L. O. Howard, who is in charge of this branch of the work, has, during two years, secured in European countries collectors who gathered infested nests, larvæ, pupæ and egg masses and sent them to Boston, simply by the thousands. In the Saugus woods a farmhouse has been turned into a laboratory and surrounding this is a colony of tents, screen houses and sheds, containing cages of all kinds.

All the material received is carefully opened, its source and condition noted and the specimens are separated as may be needed and placed so that whatever parasites they contain may develop.

But that is not all: primary parasites are themselves subject to parasites and it is intended to prevent the introduction of these secondary parasites so as to leave a free field for the primaries. Everything is therefore secured in closely screened cages or in dark boxes in which holes are bored admitting light, but plugged by glass tubes. The parasites, when they emerge, fly toward the light and get into the tubes where they are readily seen and their characters recognized. Secondary parasites are invariably destroyed: the primary parasites are liberated under a system which is believed to give them the best chances for propagation.

There are many variations from this general scheme to suit special cases and, indeed, so far as possible each species secured in numbers is treated in such a way as seems best adapted to secure best results; but in general the scheme is as described.

It is too early as yet to judge as to the results of this work two or three years certainly must be allowed for the importations to get a foothold and to make an impression. That these parasites will destroy or exterminate their hosts is not expected The utmost that can be hoped is that they will keep down the injurious species to such numbers as to remove that constant threat of destruction to orchards and forests. It is an experiment unparalleled in its extent and aim: it deserves success Meanwhile the usual destructive measures will be continued to prevent the insects from further overrunning the country.

We are not altogether without natural help even now, for during 1906 disease almost wiped out the brown-tail moths in some localities and reduced the Gypsy moth materially. During my June visit, fully half the caterpillars seen by me were diseased and in some places the percentage was much greater.

Up to the present time no signs of the insect have been found in New Jersey, and none have been found, so I am advised, in New York State. But we have through freight and passenger trains from Massachusetts into and through New Jersey, and the danger is by no means remote.

Cottony Maple Scale.

This is under almost absolute control by its natural enemies at present. It was almost entirely absent in those localities where it first became troublesome some three or four years ago and it lingers in only a few of the places where it last became abundant.

One of those places is at Rahway, and on July 11th, Mr Dickerson collected a series of infested twigs. The infestation was not a bad one and was very irregularly distributed; but wherever the scales were found, there the lady-bird beetles were also present.

The collected specimens were examined in the Laboratory next day and larvæ were found in all stages, from those just out of the egg to those about ready to pupate: indeed, what were identified as eggs of the beetle were present on some of the masses.

The young larvæ, when hatched, therefore find themselves in the very midst of their food and dig at once into the cottony mass. For some time to come there will be little seen of this scale unless for once history does not repeat itself.

The Maple Pseudococcus.

This was scarcely noticed at all during the season of 1907. Even in localities where in 1906 it was very plentiful it was conspicuous only by its absence. Just what the conditions were that acted as checks I do not know; but in any case they were universal.

It will prove interesting now to find what happens to the signate lady-bird beetle which, last season, fed on this *Pseudococcus* after it had wiped out the *Pulvinaria*. The check to the *Pulvinaria* is largely to be credited to this little beetle; but the check to the *Pseudococcus* is not so to be explained.

Oyster-Shell Scales.

These insects have not been as troublesome as usual in most localities, and that period of abnormal increase, during which they threatened the life of maple shade trees in some sections of the State, seems to have passed.

Our winter applications against these insects have always been unsatisfactory. That period is passed in the egg stage, covered and protected by the dense female scale, and none of our insecticides have proved quite equal to getting through both scale and eggs. Washing the trunk with caustic soda or potash is an old remedy and quite efficient where thoroughly applied, but practically it cannot be put on well and strong enough except on the trunk and with a brush or swab. Very strong and caustic soaps have also given more or less satisfaction, and are more widely applicable.

During the winter of 1906-1907 some experiments made in England seem to indicate that the addition of kerosene to the

soap and soda will be effective. The formula that was said to kill all the eggs was:

Soft soap,	1½	pounds
Kerosene,	2	gallons
Caustic soda,	6	pounds
Water,	30	gallons

Emulsify the soft soap and kerosene with 1 gallon of water in the usual way, then add the soda and water to make up the full amount. Made up with a half pound of hard soap in the way usually recommended for the ordinary kerosene emulsion would probably answer just as well, and the material, when reduced and without the soda, would be a 1 in 15 kerosene emulsion—altogether too weak to reach any of the usual scale insects in winter form. The addition of the soda seems to open the way for the kerosene, not only through or beneath the scale, but into the egg as well. The formula is well worth trying.

The Periodical Cicada.

In the Report for 1906 I noted the fact that Brood XIV. of the Periodical Cicada, VIII. of my Report for 1889, had been practically eliminated in this State, and that not a single authentic record was received by me. Later I was informed by Mr. Marlatt of the United States Department of Agriculture at Washington, that a fairly reliable report had been received of their occurrence in Bergen county, so it may be that the brood still maintains itself with us by a slender hold.

No brood was scheduled for 1890, and yet in that year a few examples were reported from Staten Island, from Essex county, and from Anglesea. These records and others from New York and North Carolina induced Mr. Marlatt to enumerate a Brood XV., as an off-shoot from XIV., and made it a matter of some interest to note whether the insects would be present in observable numbers.

From Staten Island Mr. William T. Davis reported hearing the insects at two points 10 miles apart and taking several pupa cases. Personally, during a September ride through the Island,

I saw a number of trees which showed the characteristic, dead and broken tips indicating the egg punctures of this insect.

In New Jersey quite a colony occurred in Union county, extending from Plainfield to Westfield, and probably for some distance round about. This colony was reported by Mr. Davis, and on July 4th, Mr. H. H. Brehme collected a number of pupæ. One of the correspondents of the United States Department of Agriculture reported to Mr. Marlatt that he heard them several days in late June near Westfield.

Mr. Davis informs me that at Newfoundland, in Morris county, the insects were heard by an acquaintance whom he considers entirely reliable and familiar with the song of the species. This gives the species a somewhat greater range than previous records, but from the same general region.

On the other hand, the Essex county colony seems to have disappeared. None of the members of the Newark Society saw anything of them, and on July 1st, Mr. E. L. Dickerson spent the entire day in the wooded portions of the county without hearing a sound or finding any traces of adults or pupa-shells.

Nor could I get any trace of the specimens in Cape May county, either from observations made in June and July, or from late September examinations of tree tops. I spent two days in lower Cape May county in mid-September, and neither on Five-mile Beach nor on the mainland did I see any trace of the insects or their work. The same record must be made for Hunterdon and Somerset counties so far as I covered them on my various trips, and Mr. Dickerson, who has been in almost every county in the State in nursery inspection work, reports no signs of their presence. It is doubtful whether this brood will ever again be reported in New Jersey.

The next brood of these insects is due in 1911, and will be a large one.

INSECTS INJURIOUS TO FIELD CROPS.

Among the curiosities of the season was the almost total absence of potato beetles in many localities, and the generally small infestation throughout the State. In only a few localities were

the insects abundant enough to do any real injury, as against many where no spraying at all was done. The control agent was climate, not parasite or other enemy or disease. The early warm weather hastened the development of the hibernating forms, and the following cold and wet spell, long continued as it was, seemed to sap the vitality of the insects and caused their death. When, finally, the potatoes did get above ground the beetles were not on hand to attack them. The check is only a temporary one, of course; but it may be noticeable to a marked extent in 1908.

Cut-worms, while not so generally injured by the adverse climatic conditions, were also affected by it, and were not so abundant and destructive as usual. There were local exceptions to this of course, but that was the general condition.

On the other hand, as usual, a few other species found the season especially to their liking, and appeared in normal or even increased numbers.

Wire-Worms.

Wire-worms were quite abundant in a number of places during the year and a considerable variety of crops were attacked.

Mr. Dickerson came more directly into contact with them in the course of his cabbage-maggot work, and secured material for a number of laboratory tests.

"Killarvæ," "Antidin" and "Vaporite" were the materials used and, briefly stated, all the tests ended in one way—the wire-worms were not in the least injured. The method was to fill a battery jar nearly full of moist earth, stock it with a definite number of wire-worms, and put in two or three slices of potato as food. The cut pieces were forced down into the soil about two inches; but one end came to the surface for convenience of examination and removal.

The materials to be used were placed on the surface and washed down with water or were dissolved or suspended as the case might require.

"Killarvæ" was referred to in the report for 1906, and is again mentioned elsewhere in this report.

"Antidin" has also been mentioned in previous reports and

more extensive experiments would have been undertaken had it been possible to secure a supply of the material.

"Vaporite" is an English product put on the market by the "Strawsons" of London, and is a tar product of some kind. It much resembles an impure naphthaline and naphthaline is one of the ingredients. The material was well spoken of by Prof. George H. Carpenter, of Dublin, in his Reports, and at my request he sent me a sample. A representative of the Company called at the Laboratory during my absence from New Brunswick, so only the small sample sent by Prof. Carpenter was available for an experiment with the wire-worms.

In so confined an area the chances were all against the insects and any material used might be expected to produce its maximum effect. Nevertheless, Mr. Dickerson's notes show only one dead worm in each jar.

Incidentally, in the field, it was noted that the wire-worms fed on cabbages dipped in arsenate of lead and hellebore with as much relish and as little discomfort as on any others. On the other hand, the carbolic acid emulsion seemed to be quite as effective against the wire-worms as it was against the maggots.

Wherever wire-worms were much in evidence, moles were observed to follow and plants situated along the lines of their runs were found practically clear of infestation. At Riverton, robins were observed hunting about infested cabbage plants under such conditions as to make it almost certain that the birds were feeding on the worms.

The Army Worm.

Leucania unipuncta Haw.

The life cycle and a record of the occurrences of this species during the season of 1906 was published in the report for that year, and it was suggested that the absence of parasites on the specimens observed, might portend a greater number during the season of 1907. So far as the Woodbine locality was concerned, this increase did not occur—on the contrary, though Prof. Pincus promised to notify me promptly of the occurrence of any destruc-

tive numbers, there seemed to have been no trouble at all. In th State at large, however, the larvæ were much more abundant tha in 1906, and chiefly south of Middlesex county. Several cran berry bogs were injured by them during the season and just afte the middle of July, they appeared in Middlesex county.

On the 17th of that month Mr. Dickerson observed them in wheat field of several acres, near Jamesburg, and feeding rathe on the timothy sown in the wheat, than on the wheat itself. The were beginning to migrate to a corn field across the road, but wer checked by a furrow plowed to protect it. Thousands of then perished in the hot dusty road. Others died in great number from a disease of some kind, and it was the rare exception to fin one that did not have at least one parasite egg attached to th surface.

July 24th, report came that the caterpillars were present i numbers on the College Farm, and Mr. Dickerson found them i an oat field bounded on one side by a field of sweet corn, in charg of the horticulturist, and on the other, by a patch of field corn Migration had begun in both directions, and the sweet corn ha been sprayed with arsenate of lead as a measure of protection.

In the field corn two rows were badly infested and were suffer ing severely; the third row was less infested; the fourth was onl slightly invaded, and beyond the sixth row there were few, if any

This condition afforded an excellent opportunity to test th value of arsenate of iron, and on the 25th, at my direction, th infested rows were sprayed with this material at the rate of pound in 80 gallons of water, using 2 quarts of glucose to add t the adhesiveness of the mixture. The application was thoroughl made by Mr. Dickerson through a "Friend" nozzle, and prove very effective.

On the 27th, the treated rows were examined and very few ex amples of living caterpillars were found. Here and there one o two examples would be seen on a stalk; but the bulk of the arm had disappeared. In the sweet corn the arsenate of lead had ac complished an equally clean piece of work, and what scatterin larvæ remained, needed no further attention; especially, as prac tically all of them were parasitized. There was no appearance o injury to foliage from the arsenate of iron.

There was no re-appearance of the caterpillars later in the season and everything points to a practical exemption for the season of 1908; or at least, until late in the summer of that year.

The Corn Worm.

This insect has been more abundant in South Jersey during the past summer than it has been since 1904. During the winter of 1903–04, the unusual cold resulted in the almost complete extermination of the species as recorded in my Report for 1904, on page 560. Since that time there has been very little complaint of injury, although it has been getting gradually more abundant each year. During the early summer of 1907, specimens of the larvæ were noticed on peas, and later on tomatoes, and, in some sections in the southern counties, material injury has been done to corn, both sweet and field.

We have made no advances in our methods of dealing with this insect in corn. Insecticide applications are not yet recommended, and nothing better than fall plowing of infested corn land has developed. This process is entirely effective, however, and plowing soon after the corn has been harvested and seeding with some cover crop is strongly urged wherever the injury is notably severe.

Sweet Potato Flea-Beetle.

In some parts of Cumberland county severe injury was caused this season by the sweet-potato flea-beetle, *Chaetocnema confinis*, a species which has not been especially troublesome in recent years. But the conjunction of unfavorable weather which retarded the plants and prevented their getting a start, with the beetle attack, was fatal. A very large percentage of the plants barely maintained themselves for a time and then died. The result was a very ragged-looking set of sweet-potato fields in September, and a decided shortening of the crop.

This is a trouble which can be almost entirely prevented by dipping the plants before they are set, in an arsenate of lead

mixture, 1 pound in 10 gallons of water. The adult beetles, which do the mischief, feed along the veins on the underside of the leaves and, on properly dipped plants, would succumb long before any injury could be caused. No spraying after the plants are set is as effective as the dipping, and as this is also effective against the golden beetles and their "peddlers," it is recommended as a general practice. Arsenate of lead will not injure the plants at any strength. Paris green is dangerous and should not be used.

Melon Lice.

Cantaloupes as a crop were a failure in most sections of New Jersey. They were retarded by cold in spring, by drought (locally) later on, and about the time they were ripening the cold nights destroyed that fine flavor that is usually a characteristic of the New Jersey crop. In addition to all these climatic troubles there were local outbreaks of the melon louse, chiefly in Burlington county, which aided in impairing crop prospects. It is some years now since there has been any widespread injury from this pest, and its occurrence during the past season can hardly be said to be threat of further increase next year; but it would be the part of wisdom for melon growers to be on the look-out for it early in the season of 1908 and to act promptly when the centres of infestion are first noticed.

Squash Bugs.

Not for many years have insects been so abundant on cucurbits, and among them the common squash bug holds an honorable position, so far as prominence is concerned. It was not until late in the season that the numbers became really large and, even then, there was no danger to the crop or vines. The danger exists in the large numbers that matured and went into hibernation. Should the winter prove a favorable one for them, they may become troublesome and injurious next spring.

Incidentally, while the opportunity served, a large number of examples was collected on the College Farm to determine whether

two allied species, which had been recently described, occurred among them. These allied species have occurred in New Jersey; but heretofore only as accidentals and not on the field crops. All the specimens examined proved to be of the common species.

Squash Lady-Bird Beetle.

This species also occurred in some numbers during the summer, but did no material injury. The adult beetles usually attract attention by their curious feeding habits, eating out little semi-circular areas at the margins of the leaves; but the yellow, spiny grubs, which really feed much more freely, are, as a rule, unnoticed. No trouble is to be anticipated from them.

Caterpillars on Cabbage.

The common caterpillars became extremely abundant late in the season and, where no spraying was done, very decided injury was cuased. So abundant were the white butterflies early in September that along the line of the railroads in South Jersey in some places it seemed as if from both sides a continuous shower of white paper fragments was thrown from the windows. I do not remember ever having seen this species more abundant; but, though very decided injury was caused, it was not in proportion to the number of the butterflies.

The truth is that cruciferous weeds of all kinds were also extremely plentiful, and there was plenty of food for all the caterpillars that hatched. The character of the season was, of course, primarily to blame for this, bringing the development of crops together in such a way that cultivation was perforce neglected for lack of help to do all things at one time. And when once the weeds do get ahead it is the exceptional farmer that catches up with them later in the season.

As for the cabbages most growers have found by experience that the arsenites, promptly and thoroughly applied, are both safe and effective. Paris green is the usual material, but arsenate of

lead is coming into more general use. In a few cases the poison was applied dry, the users claiming that it sticks better than a spray; and that is undoubtedly true when the application is made with a sprinkling pot or through a coarse nozzle. The addition of soap helps this trouble, and the forcible application of fine spray will usually leave poison enough on the outer leaves to prove effective. I have not been able to find that resin soaps have been employed, and those with whom I have spoken on the matter consider it too troublesome to make and too expensive to buy.

ROOT MAGGOTS.

The results obtained in a study of the onion and cabbage maggots in 1906 are summarized in Bulletin No. 200, published in February, 1907, and the details of observations and experiments made are more fully set out in the report for 1906.

During the season of 1907 observations were continued, and a few experiments were made to test some of the conclusions reached in 1906 and some of the methods of control recommended. The work was limited to the cabbage maggot and was chiefly done by Mr. E. L. Dickerson, following out the plans agreed upon with the Entomologist. The notes on field results were also made by Mr. Dickerson, who secured the continued co-operation of Mr. Howard G. Taylor, of Riverton, and induced Mr. W. E. Black, of Mercerville, to try some of the recommended methods. Whatever material appears in this account in quotation marks is from Mr. Dickerson's notes.

The erratic appearance of the maggot noted in the report for 1906 was very marked in 1907; some of the worst-infested localities of 1906 showing little injury in 1907, while some other places were much more troubled.

Mercerville Observations.

Mr. Black's cabbage patch consisted of "several thousand plants set in a yearling peach orchard, rows of plants being

Fig. 1. Placing tarred paper discs on cabbage plants, on Black fa

placed between the rows of trees and the rows containing approximately 300 plants each."

April 5th the plants were being set out and the first of the experiments were made to test the effects of dipping the plants in arsenate of lead and in hellebore powder in preventing the maggot attack. In a pail of water one ounce of soap was dissolved; in this the plants were dipped, head down, as far as the roots, and they were then rolled in or sprinkled with the powdered hellebore so as to cover thoroughly, stems being particularly well treated. Nearly 800 plants were so treated, allowed to dry slightly so that the powder might adhere well and were then carefully planted. Nearly 900 other plants were dipped in the same way into a mixture of arsenate of lead at the rate of 1 pound in 3 gallons of water, a little soap being added to help its adhesive powers. These plants were also allowed to dry a little before being set, to allow the poison to set well on the surface.

On April 12th 300 tarred-paper discs were placed on as many plants. As the cabbage had been set rather deeply it was necessary to remove some of the surface soil so as to place the discs and get them to fit snugly around the stems. Nevertheless the work was done quite rapidly.

On April 26th adults of both sexes occurred in small numbers throughout the patch, and, as it was quite windy, they kept close to the ground. There had been quite a storm with heavy winds, and some of the paper discs had been dislocated or altogether torn off. "It was interesting to note that the discs had not prevented the cut-worms from working on several of the plants and destroying them." Neither the hellebore nor the arsenate of lead had injured the plants in any way.

April 30th, the flies were much more numerous and at one point a number of males were dancing in the air several feet above ground. Oviposition had begun and eggs were found on a number of plants, including some that had been treated with hellebore and arsenate of lead. None were found about the plants protected by the tarred discs. Some of the eggs were removed to the laboratory, where they were hatched a few days later.

May 8th, fewer flies were seen in the field, but these were ye ovipositing and many more eggs were found about the plant than at the previous record. "In a few cases the eggs were placed against the stems; but usually they were concealed unde a small lump of dirt or elsewhere about the stem. Sometimes a dozen occurred in a single cluster and as many as 18 were note about several of the plants. At this time, too, eggs were note about a very few of those treated with the tarred paper discs although in such cases there was more or less dirt over the discs.' This dirt covering was due to cultivation, for while the attemp was made to keep clear of them, it was not always possible t keep the soil from being thrown on the papers. Recently-hatche larvæ were now found on a number of plants, and an occasiona specimen was further advanced. A period of cold damp weathe since egg-laying began had retarded development.

"One of the rows that had not been treated in any way wa used experimentally at this time. The surface dirt was quickl removed from around the plants, and with it the eggs that ha been placed there, and this was replaced by other soil. All thi could be done very rapidly."

Near to the Black farm Mr. E. L. Riley had fields of cabbag and cauliflower which had been infested in 1906, and parts o these plots were sprayed with whale oil soap at the rate of 1 poun in 4 gallons of water. The odor of the soap was quite apparen for some time afterward, and Mr. Riley claimed that the flie were much less abundant where it had been used.

Several of the rows not under experiment on the "Black' farm were, about this time, sprayed with the carbolic acid an lime mixture described in the report for 1906. On May 10th, a second application was made on the plants previously treated and the remaining rows, which had not been treated in any way were given a dose of carbolic acid emulsion, after the surface dir had been removed from the plants.

May 13th, some flies were still about, eggs were yet being de posited, and a few more were found on dirt-covered paper discs May 18th no more flies were seen, but there were yet some un hatched eggs. There was a scattering infestation throughout th plot, but nothing bad anywhere, except on a couple of rows on th

further side of the field which had been left as checks—untreated and uncultivated. Here there was considerable infestation "and it was interesting to note that the maggots in many cases were found about or in the leaf-stems: due to the low planting of the cabbages." Incidentally a few wire-worms were observed feeding on the roots at this time.

May 28th, conditions had not changed much and throughout the patch, except in the check rows, the infestation was slight. In the check rows all stages from very recent larvæ to puparia were found and some of these puparia developed in the laboratory to the adult stage June 16-19.

June 24th, matters had advanced somewhat. There was no greater infestation than before and some of that was on plants dipped in hellebore and on those dipped in arsenate of lead. Adults were noted in the field, and on the flowers of some cabbages running to seed. The females had the abdomens fully distended with eggs, but none could be found about the plants. The majority of the insects seemed to be in the pupa stage and the conditions as to development were found identical on the Black and on the Riley farms.

During July the flies became first more numerous and then ever less abundant; but no eggs could be found either on the cabbages yet growing or on the stumps left after cutting out the head. Harvest began early in the month and continued into August. On July 25th, the flies had disappeared, leaving no infestation on these patches. On the Riley farm a patch of young late cabbage was as free from infestation as the old plants, but on some wild radish plants full-grown maggots were found.

August 21st, the harvest was over and the fields were cleaned up; the remnants showing no appearance of maggot infestation.

October 10th, a final examination was made and now, on the Riley farm, both turnips and radishes were found to be infested. The turnips were so badly infested as to be mostly unsaleable, and the radishes were not much better. It was interesting to note that there were many volunteer radish plants scattered about the place, and on a large number of these nearly full-grown larvæ were found.

The plots on the whole, on both farms, had been freer from maggot attack than might have been anticipated from the number of flies present early in the season and the number of eggs found. There was more infestation on the untreated rows on the Black farm, and the difference may be due to the treatments made. It may also be, in part at least, due to the fact that the untreated rows were not cultivated either, and therefore there was no disturbance of the eggs laid, at any time. The peculiar feature is the freedom of cabbage plants from injury during midsummer, although there were plenty of flies about, and the destructive increase of the fall brood.

Riverton Observations.

The area under observation here consisted of a small plot of several hundred plants set out by Mr. Taylor for the purposes of this experiment only. It was on the same ground used for the same purpose in 1906, and was infested territory. The plants were set just after the middle of April, and 600 of them were dipped: half in hellebore and half of them in the arsenate of lead mixture as described in the record for the Mercerville experiments.

April 23d, the plants appeared somewhat wilted from adverse weather conditions, but were otherwise in good shape. A day or two afterward Mr. Taylor applied tarred-paper discs to 25 plants not otherwise treated.

May 8th, adult flies were found active; many eggs were found about some of the plants and a very few of these had hatched. Wire-worms, however, were found working in considerable numbers, especially in one end of the patch, and considerable injury had already been caused. As many as 18 were noted about some of the plants.

May 15th, very few flies remained. Eggs, unhatched and in good condition were plentiful, and there were also many recently hatched larvæ. The infestation was evenly scattered throughout the patch, and "just as bad on the dipped plants as elsewhere. This treatment, therefore, has been of no apparent value, although it had not hurt the plants." Some of the recently hatched mag-

Fig. 2. Riverton Experiments. The large plants are those to which tarred paper discs had been applied.

gots had already penetrated to a depth of 2 inches beneath the soil. Wire-worms had injured the plants up to that time more than the maggots, and they in turn had furnished food for the moles. Mr. Taylor also reports noting birds, "which he believed were robins," working around the infested plants, and it is quite probable that they were feeding on these same wire-worms.

A number of infested plants were now treated with "Kill-larvæ," a material described in the last report. In all cases a cup-shaped depression was made around the plants to be dosed. In some the two powders that produce the active insecticide were mingled, placed in the cup, and water was poured in. In others the mixture was made up fully, and the liquid combination was poured into the cup. Rain interrupted the work, which was continued on the 16th by Mr. Taylor, as follows:

1. One dozen infested plants were taken up with the surrounding soil. The soil was shaken off, the plant was freed from attached larvæ and adherent eggs and then reset.

2. One dozen infested plants were taken up and cleaned as before, and half were then dipped in hellebore decoction—2 oz. of powder in 1 gallon of water—while the other half was dusted with the dry powder before resetting.

3. A cupful of the carbolic acid emulsion was poured around the base of each of one dozen infested plants.

4. Hellebore decoction—2 oz. in 1 gallon of water—was poured around the base of one dozen infested plants—one cupful to each plant.

5. Powdered white hellebore was placed around the base of each of 12 infested plants.

May 24th, the plants of the 1st experiment were a little wilted, but otherwise in good condition.

The plants of the second experiment were equally good and had not been injured by the hellebore treatment.

"The carbolic acid emulsion had penetrated the soil to some extent, had killed all those maggots with which it came into contact, and had not injured the plants. It is interesting to note that where it came into contact with wire-worms these also were killed. The hellebore decoction had penetrated less than the carbolic acid

emulsion, but appeared to have killed the maggots with which it came into contact."

Both the wet and dry hellebore had acted primarily to drive the maggots deeper down into the soil; but these as well as the acid were applied too late for the best results, and the insects were mostly out of reach.

"The best results had been obtained with the tarred-paper discs. On only one plant were maggots found working, although eggs had been observed about some of the plants so treated, early in the season, and this one exception was undoubtedly due to the fact that the discs were applied rather late. In addition, new roots had started near the surface of the ground below the cards."

June 25th, no more maggots were found, and no flies were yet seen, hence, as some puparia were present, it was concluded that the insects were mostly in that stage. Results of the maggot injury were now conspicuous, and the plants to which the tarred-paper discs had been applied stood out in sharp contrast to the others.

Thereafter the insects seemed to disappear, and when nothing new developed on July 15 and 25, the patch was cleaned up.

A number of other cabbage patches in the Riverton district were visited for the purposes of comparison, and all were found exceptionally free from maggot attack, in sharp contrast to the conditions recorded in 1906.

Husted Observations.

In the Report for 1906, the conditions found on the Seabrook farm near Husted are given in some detail. May 25th, it was found that while there had been some injury, it was not nearly so much as in 1906. "Cabbage had been planted on March 27th, and twice a week, thereafter, the dirt had been pulled away from the stems until a couple of weeks ago, when the dirt had been hilled up around the plants. Upon examination a few full-grown maggots and puparia were found, and a very few freshly-emerged flies were seen about the patch. Evidently many of the eggs had been removed by the process, and the few insects remaining were those which had been missed in removing the dirt. Tarred-paper

Fig. 3. Wild radish roots infested by cabbage maggots.

discs had been placed around some of the plants from about the stems of which some of the earth had been removed. The work was, therefore, a little tardy, and the plants appeared to be in the same condition as the others, save that new roots were making a fine growth under the discs."

General Conclusions.

The root maggots on cabbage were not, on the whole, nearly as abundant in 1907 as they were in 1906, although there were plenty of flies in the fields in April and May. Adults were first seen April 26th, and eggs a few days later. During the early days of May, flies increased in number, and then decreased until, soon after the middle of the month, no more of the first brood were found. Larvæ began to appear early in May, but were retarded in development by wet, cold weather, and pupation was not general until late in May. At Husted, in Cumberland county, the first adults were noted May 25th, but from puparia taken at Mercerville, in Mercer county, adults did not issue in the laboratory until June 16th. In the field, flies were noted until mid-July, although at that time in very small numbers. The late brood of maggots was in turnips and radishes, October 10th, at Mercerville, and the indications were that these maggots would not get beyond the puparia stage during the season.

Results of Experiments.

Dipping the plants in arsenate of lead or in dry hellebore was of little or no value. Plants so treated being as badly infested as any others.

Tarred-paper discs were distinctly effective. Several hundred were used all told, and, although eggs were found on some that had become dirt-covered, on only two plants were maggots found later. One of these cases is explainable by tardy application. The Husted work is not included here for reasons given previously. It seems that the eggs dry out on the tarred-paper surface and never hatch. The eggs were found only on those

discs that had become partly soil-covered in cultivating. "In thi respect the work on the Taylor place was interesting. The plant where the discs were used not only made a better growth, on th whole, than the others, but with the exception of one plant the showed no infestation, while the plants immediately next to ther on either end of the row showed it very distinctly. Judging b the results obtained there is no doubt that this treatment is thor oughly effective; but the discs must be applied when the plant are set, or immediately afterward, before egg-laying begins."

The cards used in our experimental work are a commercia article sold by W. H. Gassert of 49 Beekman street, New Yor City, at rate of two dollars per thousand. They can b equally well made at home as described in Bulletin No. 200.

Brushing away the surface soil from about the stems of th plants and replacing it with fresh soil removes the eggs laid nea the plants to such a distance that the young larva, when i hatches, finds no food at hand and starves or dries up in its at tempt to find a suitable plant. As the eggs are laid just beneat any surface shelter near by this brushing away and rubbing th stems of the plants is very rapidly done. Several hundred plant were treated in this way on the Black farm and very few eggs wer missed. This work must be done within three or four days afte oviposition begins, and must be repeated at 4 or 5-day interval so long as flies are observed in the fields.

Carbolic acid emulsion prepared as described in the Report fo 1906 and in Bulletin No. 200 is effective whenever it reaches th insects. It should be applied as soon as possible after the mag gots have hatched and before they have gotten either deep int the soil or have bored into the plant tissue. It is better to form a "cup" around the plant to be treated so as to hold the mixtur and force it to soak into the ground around the plant. It wil require several applications to secure satisfactory results.

Carbolic acid and lime applied by Mr. Black on part of hi patch was undoubtedly effective to some extent in checking injur by the maggots.

Hellebore in the form of a powder placed in a cup around th stem of the plants was not very effective. Hellebore decoctio

applied like the carbolic acid emulsion was effective in that it killed all the insects it reached, but it is not so penetrating as the acid and must be applied even more carefully and more frequently to obtain satisfactory results.

Taking up the infested plants carefully, cleaning and resetting, works perfectly, and when plants are so badly infested as to show injury, or when the maggots are low down on the roots, this is about the only effective thing that can be done. On a field patch it is not a practical method. In the garden or on a small plot it is a satisfactory proceeding. Growth will be retarded for a few days, but no other ill-results have been noted.

Recommendations.

If cabbages are to be raised in infested territory, and injury is anticipated, nothing is better than tar-paper discs, applied when setting or as soon afterward as possible. If discs are not applied watch for flies in the field, and after these are noted look for eggs. When eggs are found in numbers brush away the infested soil from about the plants and replace it with soil that is clean. Or, a week after eggs are noted, apply the carbolic acid emulsion and repeat twice at intervals of five days. In any case prompt and thorough work is required, and too much stress cannot be placed upon the element of promptness.

These recommendations are based on the results of 1907 work only, and do not exclude the suggestions found in Bulletin No. 200.

The observations made late in the season emphasize the importance of getting rid of all cruciferous crop remnants and of all cruciferous weeds so far as possible. Late turnips or radishes, if they become infested, should be turned out and used or destroyed to prevent the maturing of a hibernating brood.

It should be realized that these maggots will develop on any cruciferous plant, and that we can never hope for clean cabbages if we confine our work against the insects to the cabbage patch.

MISCELLANEOUS.

The Rose Chafer.

This species was at least no worse than in 1906 and was pr
ably a little less abundant. It was plentiful enough in many loc
ities and caused considerable loss; but it was not so universa
present nor so obtrusively noticeable in the field. I did not fi
it so abundant in the orchards and there were markedly sma
numbers on flowers. Grapes suffered more than other fruits,
even these were only locally affected.

Cranberry Insects.

While there is nothing new in the way of insect pests to be
corded, neverthless conditions of climate and temperature ex
cised so important an influence on the development of the usu
species that injury was caused in spite of practice which, in or
nary seasons, is sufficient to secure exemption. At the ordina
period of drawing the water the weather became cold—ve
cold—and the hatching of eggs on the bogs was abnormally
tarded. Vegetation started before the eggs hatched, and reflo
ing, done at the usual time, failed altogether to be of benefit
cause there were no larvæ to be reached. After the water w
taken off the eggs hatched, and unexpected injury resulted. So
growers that reflowed very late secured good results; others th
held the water very late secured equally good results. August
I was on the Wills bogs in Burlington county and found the lar
of the first brood just mature on the lower portions of the bog a
adults in abundance on the higher areas—just one month behi
normal conditions. The whole experience indicates the i
portance of observation in advance of practice. There is no
reflowing a bog to kill insects, until there are insects present
a condition to be killed.

Another new factor in the insect situation on cranberry bogs
caused by the practice of spraying with Bordeaux mixture to p
vent injury from scald, rot and other fungus troubles. Sugg

tions that bogs be sprayed have not been favorably received by cranberry growers in the past; but the demonstration that the destructive disease could be controlled has changed this attitude to a very marked extent. It adds nothing to the cost of spraying except the cost of the insecticide to add Paris green or arsenate of lead when applying the Bordeaux mixture, and this had already been done, with good results, by a few of the growers.

All the foliage feeders will be reached by this process, whether they are injurious or not, and whether they feed on the cranberry plant or on other bog vegetation. Grasshoppers, crickets and katydids are much reduced in numbers or altogether wanting on sprayed bogs, and a plant poison-coated will resist the later broods of even the black and yellow-head caterpillars.

Army-worm invasions, such as occurred in several bogs during the season, are impossible on sprayed bogs where arsenicals are applied with the Bordeaux mixture, and for lasting qualities arsenate of lead is preferable to Paris green and not much, if any, more expensive.

The Chinese Mantis.

This insect seems to have a precarious hold in several parts of the State; but has nowhere increased enough to become conspicuous. During the past summer single specimens have been seen, here and there, one of them in my own garden. No egg-masses have been found in any of the localities where the introductions have been made, and in some way conditions seem to be more unfavorable than in Pennsylvania, where the insect more than holds its own.

To the continued courtesy of Mr. Philip Laurent, I owed an additional supply of egg-masses in January, 1907, which were tied out by Mr. Brehme on Great Island and Bushtown, at the edge of the Elizabeth salt marsh, a totally different locality from those heretofore selected.

Nothing was seen of the insects during the summer, although Mr. Brehme made a special search for them late in the season; but when the foliage is all down, a new search may show better results in egg-masses. At all events not much can be expected of

these insects for some time unless they make an altogether n record for adaptability.

A New Importation.

During the inspection work in an Essex county nursery M Dickerson was shown a specimen of a longicorn beetle, which h been captured there during the summer and, as it was unfamil to him, he brought it with him. It was equally unfamiliar to n except that I recognized it as not native to the United States, a therefore I sent it for identification to Mr. Carl Schaeffer, of t Brooklyn Institute of Arts and Sciences. He made it out to *Melanauster chinensis,* a common Oriental species, but could t me nothing concerning its habits.

Inquiry at Washington resulted in the following letter fro Dr. L. O. Howard, Entomologist to the United States Depa ment of Agriculture: "Dear Doctor Smith: Your letter September 18th had been turned over to Mr. Schwarz, and, aft some delay, he submitted the following statement:

" 'It is not the first time that the *Melanauster* has been fou in North America. Some years ago I determined the species f a California correspondent of this Bureau. It was found Southern California, where it had emerged from a young fr tree. I unfortunately forgot what kind of a tree it was, but came from Japan, and had passed through the horticultural qua antine at San Francisco.

" 'There is nothing to be found in the literature available me regarding the food habits of the genus *Melanauster.* The is, however, a figure in Professor Nawa's Journal, "Inse World," and there is probably an article referring to its life habi Being ignorant of the Japanese language, I cannot read the arti in question. However that may be, the genus *Melanauster* closely allied to our North American *Goes,* which, as you are w aware, attack healthy deciduous trees, such as hickory, elm, et and occasionally do considerable damage. *Melanauster chinen* is widely distributed in the Orient, occurring over the largest pa of northern China, and being found extremely abundant in Japa

"I remember the California correspondent named by M

Schwarz was Mr. S. A. Pease, from San Bernardino, who found that *Melanauster* emerging from a young orange tree imported from Japan."

ENTOMOLOGY IN THE CROP BULLETIN.

The season started with a memorandum in the April number, in which the Secretary of the State Board of Agriculture reviewed orchard conditions and stated that: "There are yet many good apple orchards, but many more are ruined by the ravages of the *San Jose Scale.*" In the same number is a note from Preakness, Passaic county, that "Peach trees are all right and seem to be free from scale. Apple trees, in some places, are all right, and in others they are nearly dead from the scale." In the July number, Park Ridge, in Bergen county, notes that the "San José scale is not as active as in former seasons." In Piscataway, Middlesex county, on the other hand, "Fruits, owing to the scale, are very poor and not much of it." In August, Secretary Dye records that "There is a belief by some that the San José scale is not so abundant and is less destructive than heretofore." At Baptisttown, Hunterdon county, however, the note is, "Scale still destructive;" while Locktown, in the same county, bears out the Secretary's conclusion by the note that "The scale, so much dreaded, seems to be on the wane, and many fruit trees show signs of life and activity." In September, Hopewell, Mercer county, reports that "The scale is yet upon the fruit trees, and many have died since last spring; where spraying has been well done, it seems to have been effectual." In October, Riverton, Burlington county, reports that pears are "Not so much disfigured by scale as in former years."

Onion maggots are noted from Cedarville, Cumberland county, in the May number, as doing much injury to the crop; but that seems to be all that was noted concerning them.

In June "*Potato bugs* appeared in great quantities" at Woodstown, Salem county; but it is added that "the sprayer has done effectual work." In July a scarcity of the insects was reported from Layton, Sussex county; Park Ridge, Bergen county; Livingston, Essex county, and Locktown, Hunterdon county; all in

the northern half of the State. In August, Baptisttown, Hunt don county, boasts "No Colorado beetles seen, having become a parently practically extinct." This is altogether a remarka record for this common species.

The *Rose bug,* though it was common enough, was only ferred to once, and that incidentally, in July, from Park Rid Bergen county, in the statement, "Grapes, where the rose b did not attack the blossoms, will yield well."

Flies on cattle were unusually troublesome, and were refer to in July from Park Ridge, Bergen county, and also fr Woodstown, Salem county, where spraying milch cows "w a carbolic acid solution has become quite popular."

Apple plant lice were reported as curling the leaves in July, Livingston, Essex county, but seem not to have attracted attenti elsewhere.

Cabbage worms first attracted attention in August, at Ma wan, Monmouth county, where they were doing some dama In September they had gotten to be "very troublesome" at E Harbor City, Atlantic county, and finally, in October, they we reported as having been very destructive at Blue Anchor, Camden county.

Melon lice also appeared in August in numbers great enou to attract attention, at Mickleton, in Gloucester county, wh they are associated with blight as causing injury to cantaloup

Grasshoppers were accused of eating cranberries in August, Hammonton, Atlantic county, in September. Egg Harbor Ci Atlantic county, reports "Cranberry crop light on account grasshoppers," and in October another Hammonton report mak them in part responsible for a 25 per cent. shortage in the cra berry crop.

Fall web-worms attracted attention once only, despite th almost universal abundance. Hopewell, Mercer county, reports September: "The caterpillar is weaving his web, and it is n unusual to see trees almost covered over; the most effectual re edy here is the torch, which is being applied."

INSECTICIDES.

The most conclusive and satisfactory tests of insecticides are those made in the field, under ordinary field conditions; but the applications should be made in such a manner and at such a proper time as to give the material tested a fair opportunity to do its work. I prefer, therefore, so far as possible, to test all materials sent me in the orchard or field and to make the applications under office supervision. Where a trial over a larger area is desirable material is distributed to farmers or fruit growers with whose methods I am familiar and whose statements as to what was done can be trusted, and even here I try to verify conditions and conclusions so far as possible.

The crucial test of any material is its use in the field by the average agriculturist or horticulturist and his help. A material that is effective under such conditions needs no other recommendation; but failure in them should not necessarily result in condemnation.

During the season of 1907 a few materials have been tested under office supervision; but a very large number of examinations have been made of results obtained in practical work and some of these are recorded here.

The Lime and Sulphur Washes.

These have continued to form the leading subjects of insecticide study and experiment throughout the country and on the whole, perhaps, their use may be said to be more general than of any one other scale-killer. They have not gained in favor in New Jersey, though they have fully held their own.

The summarized results of practical experience and of experimental records may be set down as follows:

Any combination of lime and sulphur, no matter how produced, so long as all the sulphur is fully combined with the lime, is effective as a killing agent against the San José Scale.

Practically, in the hands of the average fruit grower, the boiled mixture has proved the most reliable and the results have been best.

Salt is not necessary to the mixture, adds nothing to its killing qualities and nothing to its mechanical condition. On the matter of adhesiveness there is some conflict of opinion; but the weight of evidence is that no material advantage is gained in this direction. Salt may be omitted altogether from the combination.

If the lime is good, one pound is more than enough to take up one pound of sulphur; if there is any considerable percentage of impurity it requires more, so as to get a sufficient amount of actual lime. With lime of such ordinary good quality as is obtainable throughout New Jersey, one pound is sufficient for use with every one pound of sulphur. Any excess of lime is mere whitewash, adds nothing to the killing quality of the combination, makes it thicker, more difficult to apply, and renders it less able to get into crevices.

Hot washes spray easier than cold, seem to be more fluid and penetrate better for that reason; they are not more active as insecticides than when cold.

Thoroughness in application is essential. No scale not actually hit by the wash will be injured by it, and the wash has practically no spreading power. Given a properly prepared mixture, the problem of killing all the scales on a given tree is purely a mechanical one. A coarse spray put on with little force is apt to make a coating *over* depressions and plant hairs, and though a tree so sprayed may be entirely white, it is quite possible that considerable areas of surface may not have any material in actual contact with it. Such applications are apt to scale off long before the breeding season opens. A fine spray driven against the surface with great force will get into cracks and crevices and through considerable surface vestiture.

Flowers of sulphur or flour of sulphur (ground) may be used with equal effect; but the flowers of sulphur being very much finer combine more readily with the lime, hence it requires a shorter period and less heat to secure a perfect combination. The wash cannot well be overboiled; the danger lies in not boiling enough.

There are a number of incidental advantages in using the lime and sulphur mixtures that turn the balance in their favor as against other equally effective scale-killers and the greatest of these is its fungicidal quality. There is no doubt of its effective-

ness in this direction, although just how valuable it is, is not so well settled. It has been rated as equally effective with the Bordeaux mixture for winter application; but that does not seem to be borne out as to many cases. For peach troubles it does seem to be almost a specific, and it does no doubt exercise a controlling effect upon peach-leaf curl. But I have seen during the past season in Hunterdon county several orchards sprayed with lime and sulphur and yet very badly affected with curl. As the trees were also in some cases quite scaly, there is a possibility that the mixture was not a satisfactory one. As a general thing it may be said that on peach trees the lime and sulphur mixtures seem to act as a stimulant and to the improvement of their general health. It has little apparent effect upon the rot, however, so far as my observations extend.

It is more than likely that as against any diseases the spores of which lodge on the outer surface of the bark, the lime and sulphur mixtures will prove more or less effective and perhaps, in most cases, not much less so than the copper mixtures.

As against other insects, the lime and sulphur combinations are effective in the case of armored scales similar to the San José, and passing the winter in the partly-grown condition. They are much less useful or altogether useless against armored scales passing the winter in the egg stage, like the oyster-shell bark-louse; and they are of no effect against the soft peach-scale. In the case of thin scales like the scurfy scale, they answer quite well even though these hibernate in the egg stage; but against the thick covering of the oyster-shell scale I have found the material of little avail.

On the other hand the eggs of plant lice seem to yield quite readily to the washes, and it has been said to destroy the pear-leaf blister mite—which is quite in line with the known effects of sulphur against mites in general.

One cannot go very far wrong in using the lime and sulphur washes on orchard trees of any kind, whenever there is anything within their range to be dealt with; provided their limitations are kept fully in mind.

As to formula and method of making, I have seen no reason to

change my previous recommendations. Use lime and sulphu equal weights and use three gallons of water for every pound sulphur. The boiling is decidedly favored as the best method uniting the lime and sulphur and the reasons for that have b given at length in previous reports.

Rex Lime and Sulphur Solution.

One of the serious objections to the lime and sulphur mixtu is the difficulty of preparing them and the boiling and other c fit required. There have been several commercial preparatic ready to use or concentrated and to be diluted, and I have tes all of them that have come to my notice. None proved sa factory in my hands and as my experience was identical with t of others, the preparations made no way and were short-lived

At the same time there seemed no good reason why a comm cial preparation should not be a possibility, and so, when the "I Company," of Omaha, Nebraska, advertised their preparat and referred to the Entomologist of the Washington State periment Station in confirmation of their claims, I decided to the material in New Jersey. I made certain first that the re ence given was justified, and my correspondence seemed to i cate that there might really be a substitute for the home-m mixture.

I ordered and received 7 barrels and paid almost as much the freight as I did for the material which was divided as follo

To the College Farm,	1	barrel
To the Dickerson peach orchard, at Chester,	2	"
To Jos. H. Black, at Hightstown,	1	"
To Horace Roberts, at Moorestown,	1	"
To Clayton L. Andrews, Moorestown,	1	"
To W. P. Pray, Kinkora,	1	"

The material used on the College Farm could not be conside in estimating results, because the infestation was altogether slight to make the trees fair subjects for experiments. Howe in late September the trees were all in good condition and th was practically no scale. There was certainly no increase o

spring conditions; but owing to the character of the season and the fact that the scale in this section increased very little at worst, it is not fair to credit the Rex mixture with the condition found.

On the Dickerson peach orchard there are between 500 and 600 bearing trees of good medium size, which have been scale-infested for several years and were treated in 1905–06 with Scalecide. This kept the insects in check and the trees in good condition; but there was sufficient infestation to make spraying a necessity during the winter of 1906–07. One barrel of material was opened in January but the temperature was so low that the mixture froze in the hose and work was perforce abandoned.

March 28–30 conditions were better and most of the trees were thoroughly sprayed under the immediate direction of Mr. E. L. Dickerson, using 5 gallons of material in 1 barrel of water: *i. e.*, 1 part to 9 of water. In the barrel that had been opened in January there was some crystallization; but the crystals dissolved completely when stirred. Goulds Pomona pump with 2 leads of hose and single vermorel nozzles were used and a very thorough piece of work was done.

July 20th, a careful examination was made; the gray color due to the Rex mixture was still obvious and larvæ and new sets were very hard to find. The results appeared excellent and there was promise of a fair crop of fruit.

September 30th, a final examination was made and the trees were found to be in a thoroughly satisfactory condition. Some trees seemed to be entirely free from scale and on others there was a mild scattering along the branches. Nearly 400 baskets of fruit had been sold out of the orchard which, so far as scale is concerned, is in much better condition than it was in spring when the application was made.

Conditions elsewhere in the vicinity showed a normal increase in scale development so that it is fair to credit the mixture with the results noted. The examination being made so late in the season showed the worst that could happen during the year.

The material sent to Jos. H. Black, at Hightstown, was applied largely to an orchard of peach trees so badly infested with scale that they were to have been taken out as useless. The request that an experiment be made determined Mr. Black to leave

them for this purpose and they were thoroughly sprayed in ea April from two ways. The results were all that could be expect On August 15th, Mr. Black advised me that there was scarc any live scale to be found. What little did occur was mostly the young suckers that started near the ground. In Septem I saw Mr. Black personally and was assured that the conditi had not changed; the trees were still as free as they had been th weeks previously. The application was at the rate of 1 to 1c

To test the possibility of using it as a summer application Black sprayed some rows of nursery trees in June, using 5 g lons of mixture to 100 gallons of water, and this did not inj the foliage of even peach trees. As to the effect of the mixtur this strength on scales, nothing was determined. It might larvæ and recent sets. I would not expect very much of it aga the well-set forms.

Mr. Horace Roberts applied the material on peach, pear plum and on a considerable number of trees, and these tre looked over early in July just before the summer meeting of State Board of Horticulture. Mr. Roberts had also used Sc cide, the soluble oil made by the Thomsen Chemical Comp and the boiled lime and sulphur wash. There was thus g opportunity to make direct comparisons and the Rex mixt showed results that fully equalled if it did not exceed any oth

The examination was really too early to determine just h much benefit had been derived; but it was comparative, and at end of the season Mr. Roberts was sufficiently well satisfied v the outcome of his experiment to order a carload of the "Re

The material sent to Mr. Clayton L. Andrews was applied follows: "The latter part of February we sprayed a lot peaches with the mixture one to ten. The last of March, spra again, one to twelve; also some trees one to ten. The fifteenth April we painted a lot of apple trees with the mixture one twelve." August 7th, all the trees were reported as satisfact except the apples—there was some scale on them.

I went over these trees myself, with Mr. Andrews, August 1, and the results on the peach trees were certainly all that could desired and in comparison with other applications equalled best results from soluble oil. The apple trees were young, so

of them very scaly and the painting had been done in a very sloppy manner. The conditions did not speak well for the material, assuming that the application was properly made.

Mr. Wm. P. Pray gave the following account of his work: "Have applied the Rex Lime and Sulphur solution to the following, between March 21st and 25th:

100 apple	trees,	12	years	old,	sprayed	from	3	sides.
120 quince	trees,	6	"	"	"	"	2	"
150 peach	trees,	4	"	"	"	"	2	"

Of about 40 of the above apple trees some were cut back 2 years ago on account of scale, and others have not made the growth they should have for their age. I think I covered them all pretty thoroughly."

August 26th, I visited Mr. Pray's orchard and looked over the treated trees. The quince may be eliminated from consideration because not sufficiently subject to scale injury; but the apples and peach trees had certainly been sufficiently coated to make them good subjects. The results here again were all that could be desired and even on the apple fruits, scales were scarce and present only in small numbers.

At the winter meeting of the Association of Economic Entomoligists in New York city, it appeared that several of the members present had used this combination experimentally and with good results, in comparison with the boiled mixtures.

On the whole, then, the result of such information as has been secured and of the experiments that have been made, point to the fact that the Rex lime and sulphur solution is practically as effective as the home-made mixture when diluted with 9 times its bulk of water. It seems to keep for months even after the barrel is opened and need not be warmed before applying.

This material will not supplant the home-made mixture for large orchards and it will do no more or better than the home mixture on apple and pear; but it will reach the owner of a few peach and plum trees who does not want to go to the expense of procuring a boiling outfit or the trouble of making the mixture.

As to cost, exclusive of freight, it is only a little more than the home-made mixture; but the cost of freight from Nebraska

almost doubles its price. I have had some correspondence with the manufacturers and have urged them to arrange for a local distributing point in New Jersey, and this suggestion has been favorably received but has not been acted upon at present writing so far as I have been informed.

Soluble Oils.

This subject, so far as it refers to commercial preparations, was dealt with at some length in the report for 1906, and there is not very much to be added in the matter of directions.

"Scalecide" is still the most generally used of these materials and its use is increasing faster than the general percentage of increase of those using insecticides against the pernicious scale. Effects have been quite satisfactory on the whole where the 1—15 mixture was used and almost perfect results have been attained in many cases with two sprayings.

A great many orchards—chiefly apple and peach—were examined by Mr. Dickerson in Hunterdon, Warren, Sussex and Morris counties on special trips intended only to get the fruit growers' experience, and I have seen many orchards myself, chiefly in the southern counties, of apple, pear and peach.

Good results were almost universal; failures were few, but did occasionally occur, and perfect results were even more rare. It has been definitely demonstrated, however, that actual extermination is possible with soluble oils on even large apple trees, while there is no particular trouble about keeping the insect in check.

A long enough series of years has now elapsed to make it safe to say that no harm is caused to trees of any kind by repeated applications of soluble oils, and that they may be safely used as often as may be needed. Nothing remains on the bark that can not be either evaporated or washed away, and there seems to be no penetration through the outer bark and into the bast tissue.

A distinct value as a fungicide has been demonstrated in the case of those peach orchards in Hunterdon county that were in the "leaf-curl" area. Trees sprayed with "scalecide" had

much less curl than others of the same variety unsprayed, but the results were not so good as those obtained with the lime and sulphur. On yellows I could not find that there was any effect whatever. Nor could I find any effect on the rot, or on any of the diseases of the apple or pear.

I have seen no reason to change my opinion as to the value of these oils, but have been rather confirmed in it by another season's observation.

In one point it has proved itself superior to lime and sulphur, even on peach trees. Many nurserymen are fixed in their belief that fumigation is injurious to buds and they prefer to run the risk of budding in scale rather than treat their budding wood in this way. Absolutely clean sources of supply are rare now-a-days and nurserymen quite usually spray in the bud to avoid infestation. Trees are very apt to become dirty so near the surface of the ground, and in such places the lime and sulphur mixtures will not stick nor reach the insects. The miscible oils find this dirt no barrier to their effectiveness; they penetrate readily and come into direct contact with the insect beneath. This feature was brought out in the course of our nursery inspections this year.

Home-Made Miscible Oils.

Since it was practically demonstrated by the commercial products that the petroleum oils could be prepared in such a way as to be readily and easily mixed with or dissolved in water, and it was further found that such "soluble oils" were satisfactorily effective and not harmful to trees, there has been an increasing demand for some method of preparing them at home, at a less cost than is charged by the makers of the commercial materials.

In my own work I have proceeded on the assumption, based upon experience, that the average farmer and fruit grower preferred to buy an insecticide all ready made, to going to any considerable trouble to make it. Therefore I rather endeavored to influence manufacturers to make and market a reliable commercial product filling all the requirements of a satisfactory insecticide.

In the Delaware Experiment Station experiments have been made, carried on for two years or longer, looking to the discovery of some method of producing a home-made material at a less cost, and in Bulletins 75 and 79 the results of their experiments are published by Mr. Charles L. Penny, the chemist who made them. It is obviously beyond the scope of this report to go into any detail as to what has been done in Delaware; but by permission of the Director of the Delaware Station the following directions and formulas for making the combination that has been found most effective are presented; quotations being in all cases from Bulletin No. 79 of the Delaware Station.

In making a soluble oil, it is necessary first to have an emulsifier, which may be kept in stock when once made and used as needed to prepare the oil for spraying purposes.

"*Making the Soap.*—After considerable experience we have not been able to find anything better as an emulsifier than the soap made from menhaden oil, or fish oil, and potash, with carbolic acid added to help the solution. This soap seems to answer most purposes better than any other, and is easily made. It is described in Bulletin No. 75, under the first part of Formula No. 8, which is here repeated as Formula No. 28.

The "Soap Solution."

FORMULA NO. 28.

Menhaden Oil,	10 gallons
Carbolic Acid,	8 gallons
Caustic Potash,	15 pounds
Heat to 290° or 300° Fah., then add at once while still hot—	
Kerosene,	14 gallons
Water,	22 gallons
Cost, after addition of kerosene and water: 15.7 cents per gallon.	

"The caution given before may well be repeated here, viz., that this mixture is inflamable when hot; and disagreeable fumes are given off from the carbolic acid. Hence, for comfort as well as for safety, the operation should be conducted out of doors, or at least with good ventilation and freedom from fire risk. A suit-

able vessel for the boiling is a deep iron kettle, such as is used for heating water. Of course, its size should depend on the amount of soap to be made; a capacity of 25 or 50 gallons is usually suitable, though generally the larger the better, since it should not be much over half full to provide against foaming.

FIG 4.

A combined furnace and kettle made by the Philadelphia Farmers' Supply Company. Electrotype by courtesy of the company.

"A kettle and furnace combined, for use with a wood fire, is shown in Fig. 4. This is offered by the Philadelphia Farmers' Supply Company, 1916 Market Street, at the following net prices:

30	gallon	size,	$9.88
40	"	"	11.40
53	"	"	13.68
65	"	"	15.20
75	"	"	18.24

"Covers may be purchased for any size at a slight additional cost.

"The kettle should be covered by boards, or otherwise, to prevent the mixture from taking fire. A thermometer passing through a hole in the cover affords the readiest means of determining the progress, and finally the end, of the operation. When

the temperature approaches 255° or 260° Fahrenheit, foaming begins and continues until the temperature approaches 270° Fahrenheit. During the most active foaming the fire must be checked somewhat by withdrawing a part of it, or otherwise, as throwing sand on it. After the foaming partially subsides the fire is increased until the temperature of 300° Fahrenheit, is reached, when the fire is withdrawn and the soap is made. Overheating a few degrees—10° or even 20°—does not spoil the soap, but it should be avoided as it increases the fire risk. At the beginning it is best to stir the mixture with a stick or an iron rod, to keep the potash from caking on the bottom of the kettle, but it is unnecessary to continue this after the mixture is warm. A small wood fire is sufficient to boil a kettle full. The operation may last from half an hour to an hour. After the fire is removed the requisite amounts of kerosene and water are added to the hot soap mixture, very conveniently in an open barrel, to which the soap has been transferred, the *kerosene always first,* since otherwise there is danger of an explosion from pouring water on the hot oil. The whole is then thoroughly mixed by stirring. It should form a uniform liquid, very slightly ropy, and without any separation, on standing, into layers, fluid enough at the freezing temperature to pour readily, and a portion mixed with a large volume of water, five or ten times its own volume, should dissolve to a uniform liquid, perhaps a little turbid, but without any free oil. The soap thus made seems to suffer no deterioration from age or exposure to the air. A sample kept for eight or nine months in an open barrel was found unimpaired and unchanged. It does not separate into parts on standing, and hence when once made it requires no further mixing.

"In place of potash it is possible to use caustic soda, but it hardly seems to be advisable. The reaction with the soda is less active than with the potash, and frequently a residue of soda is left unacted on, so that the proportion of alkali is somewhat uncertain. While the soda is cheaper and often easier to obtain, the potash seems to be preferable. If, however, soda is used, the weight should be about the same as given for the potash and care should be taken that the soda is all dissolved. But soda is not recom-

mended. All of our experiments have been with the potash soap and at present, at least, we cannot advise the use of any other.

"The object in adding the kerosene and water to the soap is partly to keep the mixture fluid. The soap proper, that is the mixture before the water and kerosene are added, is quite solid when cold, and hence, to dissolve it in the various oils would require either heat or a long time, both requirements quite inconvenient. But in a liquid form it mixes with the oils readily. There is the further advantage that out of a number of proportions tried, the one given seems to make the best emulsions. It will be seen that the final mixture, hereafter to be called the 'soap solution,' only one-third is soap and carbolic acid, the remainder being kerosene and water. This, of course, requires larger containers. If it is preferred, the kerosene and water may be omitted, and the soap and carbolic mixture may be prepared in the form of solid bricks, to be melted when they are mixed with the oils. This would save much in the cost of packages but would be far less convenient as heat would be required, whereas the 'soap solution' mixes readily with oils in the cold. Whenever in the following formulas 'Soap Solution' is called for, the complete mixture with kerosene and water is meant.

"*Mixing the Soap and Oils.*—The 'soap solution' as just described may be mixed with a number of different oils, and usually some water, in such proportion as to give emulsions. The process of mixing the soap and the oils is simple; it is carried on without the application of heat, merely with agitating in suitable vats or tanks. If the materials are very cold, as in winter weather, the mixing is sometimes a little more difficult, especially in respect to resin oil, which becomes rather too viscid to mix readily. Thus it is a little easier to make a thorough mixture in a moderately warm room than a freezing temperature, but with good agitation mixtures may be made at any temperature at which the oils will run.

"It will be noticed that in most of the formulas water is called for, but the amount is not specified. This is because different samples of several materials such as the menhaden oil, the resin oil, the paraffine oil, etc., do not always give just the same results when mixed seemingly in the same way; and more than this, with

the same materials it is not always possible to get miscible oils exactly smilar in every way. There are slight differences in the making of different lots, according to the same formula and from the same materials, that give to the final product different characteristics. Probably temperature is one of the varying conditions, a slight change in proportions may be another, and again the thoroughness with which the ingredients are mixed may be a third.

"The proper amount of water to be added in mixing the oil is best determined by trial in each case. When the soap solution and all of the oils called for have been well mixed, a small sample of the product, as a spoonful, is tested in a glass of water. In the case of some formulas there may be an excellent emulsion, without any free floating oil, but in most cases there will be no emulsion at all. A gallon of water usually (for the quantities given in the following formulas) is then added and thoroughly mixed with the oil, and a second test is made. Probably several tests will have to be made and several gallons will have to be added before a satisfactory emulsion is obtained. A little experience will soon teach how much water is required for a particular formula under the prevailing conditions, and then the proper amount of water may be correctly estimated and added at once.

"The proportions named in the following formulas are expected to permit perfect emulsions when the preliminary amount of water has been determined and added. Nevertheless, in the use of these or any miscible oils it is just as easy to add at first to the amount of oil to be used about half its volume of water, to mix well, and then to pour this into the remaining portion of water. This is safest as a uniform practice in all cases, though in most cases it may not be necessary. It will sometimes secure an excellent emulsion where there has been failure without this precaution. The value of water in securing emulsions has been more fully discussed in Bulletin 75 under the head of 'Manipulation.'

"In the making of these oils no regard need be paid to the order in which the ingredients are added, except that the water, if any, is always to be added the last of all, after the oils have been thoroughly mixed, the quantity of water being determined by succes-

sive trials of small samples. The mixing may be done in an open barrel, which is large enough for all of the formulas except No. 29 and No. 34. Probably a larger tank, as of 60 or 65 gallons, would be a little more convenient with less danger of loss of material. As mentioned, the ingredients blend a little more easily at room or summer temperature than at freezing temperature, but cold weather is no obstacle. A more vigorous agitation is needed at a low temperature than at a more moderate, but the mixture seems possible so long as the oils will run. A cheap device for a stirrer is a small board, about 15 or 18 inches long and 5 or 6 inches wide, attached to a handle, just like a rake. The stirring is best effected by thrusting the dasher up and down, as in a churn."

The formula which was found by the entomologist to give the best result is:

Soap solution,	9 gallons
Paraffine oil,	40 gallons
Resin oil,	6 gallons
Water—as required by test,	(1¼ gallons)

Cost without added water: 16.4 cents per gallon; with water added 15.4 cents per gallon.

In the formula presented by the entomologist it was found that 1¼ gallons of water were required to make the mixture soluble. Nine gallons of water were added to each gallon of the miscible oil in the mixture as applied, making the cost of each spray gallon about 1½ cents.

"'Paraffine' oil is a trade name for lubricating or machine oil. It is a petroleum product, consisting of the heavier fractions of the crude oil. It is not volatile at the ordinary temperature, and hence would remain indefinitely on the tree if not removed mechanically as by rain. This is, undoubtedly, a most important quality.

"*Resin oil* is a product distilled from resin, of which it forms about 85 per cent. It is thick and viscid at ordinary temperatures, much resembling molasses in consistency. For our purpose it has an extraordinary value in its property of facilitating the making of emulsions with crude oil and paraffine oil. Emulsions of these

latter oils without resin oil are difficult to make. That with crude oil in the absence of resin oil required a large amount of kerosene to be added and requires some ammonia, or at least it is improved by the addition of ammonia; while paraffine oil offers still greater difficulties. But with the use of resin oil these heavy oils are as easy to emulsify as kerosene. This we may accept as a fact without any attempt at explanation, for indeed there is very little in connection with emulsions that can be explained in the present state of our knowledge. Resin itself fulfills much the same office as resin oil, and may be used instead of it; the latter is much the more convenient, however, and nearly as cheap. There is great probability that the resin oil is itself a valuable insecticide, acting mechanically as a suffocating varnish, for varnish making is one of the principle uses of resin and resin oil. It is important to note that in making miscible oils the proportion of resin oil allows less variation than that of any other ingredient; a trifle too much or too little often prevents the emulsion."

The carbolic acid should be "Liquid Crude, 100 per cent. straw color," and this strength and quality should be insisted on. The Barrett Manufacturing Company, of Philadelphia, are mentioned by Mr. Penny, in his Bulletin as proper sources of supply.

The caustic potash should be defined as "*ground* caustic potash 90–92 per cent." and may be obtained from the General Chemical Company, the Bourse, Philadelphia. This potash should be excluded from the air; but in an ordinary covered tin can it may be kept indefinitely.

Prepared as above described the miscible oil ready to use costs less than half as much as the commercial product, excluding the cost of labor. To those who may desire to experiment with preparing it I would emphasize the suggestions made by Mr. Penny as to proper materials and accurate measurements. Improper materials and careless handling will result in failure every time. Rule of thumb methods will not answer.

Another point to which Mr. Penny calls attention is the necessity of thoroughly stirring up and mixing the prepared miscible oil before using it in the spray pump. There is always a chance of a partial separation of some of the materials which can be readily recombined by stirring.

Carbolic Acid.

In the Report for 1906, I gave rather briefly some account of what we had been able to learn concerning this material as a scale-killer when applied in a band on the trunks of the trees. Persistent reports of good effects during the winter of 1906–07, although vague in character, and very positive assertions of faith in the material which were likely to induce a considerable use of it, made it advisable that we should learn more definitely what had been done.

The centre of the Flemington section faith in the acid, seemed to rest in Mr. Amos Thatcher, of that town, and to his courtesy I owe the opportunity of seeing a number of orchards in his vicinity and of becoming familiar in general with conditions between Flemington and Cherryville. Three visits were made and in four orchards it was possible to note the effects of the material.

Mr. Thatcher has a peach orchard which became so very scaly that it seemed as if it were doomed, no treatment of any kind having been made. It was dehorned in 1905, painted with a banding of carbolic acid 25–30 per cent. strength and made a good growth, free from scale in 1906. In March or April, 1907, the trees were again banded with the acid 50–60 per cent. strength much more liberally applied, and in some cases painted on the branches as well.

When I first saw this orchard in the early days of July, I found all the old wood covered by thick, hard, rough bark, utterly unfit to maintain scale and the new shoots were fresh, vigorous and clean. Not more than enough scale to swear by was found and none that was reproducing. The trees are well looked after, culturally.

There is, in addition, an apple orchard of considerable extent which has been scaly for years, and which became so scaly in 1905 that much of the fruit on some trees was absolutely unusable. The orchard was in grass, which was cut for hay, and had not been cultivated for some years. It was not sod-bound however, and the trees were in general good condition. This orchard was treated much like the peach orchard. It had a banding of the weak acid in the spring of 1906, and a much more liberal applica-

tion of the stronger material in the spring of 1907. At the time I first saw it there was plenty of living scale on the trees, but there were few cases of what might be considered a dangerous infestation. There were some pear trees also, which do not require separate consideration, since the general facts concerning them were the same. Mr. Thatcher states that the trees were in much better condition in 1906 than they were in 1905, and that the fruit was very little infested—practically none that was unusable. As to general condition that might be said to be very good. Scale breeding had just started, a very few larvæ being noticed; but it could not yet be determined how general such breeding would be later.

A peach orchard between Flemington and Cherryville had been banded with acid, but had also been treated with lime and sulphur, and had a record of lime and sulphur treatment for some years. There was very little scale in this orchard, but a horrible infestation of peach curl and quite a bit of yellows. As a test of the value of the acid this could not be of avail; but an apple orchard belonging to the same owner was in a different case. This had been sprayed with lime and sulphur for some years and had nevertheless become steadily worse, until many trees had died and were taken out. More of them were partly dead, and yet more looked as though they had very little interest in life remaining. The orchard was in sod, and had been for some years. Besides scale there was blight and about all the diseases that are usually found in an apple orchard. Some of the dead trees should not be charged to scale at all, and in others it was only one of a number of factors.

Instead of lime and sulphur the orchard received this spring (1907) a broad banding of carbolic acid. Breeding had just begun and there was already a liberal sprinkling of young on some of the trees.

One other peach orhcard was found which offered a fair test of the acid treatment without complications. It consisted of several hundred trees that had never been treated, had just come into bearing, were very scaly and had been banded with acid in the spring. The bands were not very broad and the application had not been very liberal; but every tree had a complete band

approaching one foot in width. Peach curl was very bad in this orchard, and there were many trees with the yellows. No breeding was as yet in progress.

None of the other orchards visited gave any help in this acid problem; but from a number of treated trees I cut sections of bark including painted areas, areas from points above and below and twigs and shoots from treated areas—all these for chemical analysis.

The acid used by Mr. Thatcher and supplied by him to the other users came from the Barrett Manufacturing Company of Philadelphia, and to them I applied for information as to just what was sold to Mr. Thatcher. In reply they state that "The ordinary crude carbolic acid consists of a creosote oil from coal tar, containing a specified quantity of cresol. The party you mention has been buying two grades—the 25–30 per cent. at 20 cents per gallon; and the 50–60 per cent. at 26 cents per gallon, f. o. b., Philadelphia. We understand that this material is used on the bark of trees for destroying the San José Scale. We have endeavored to get more details about this, and are told that some users have found it injured the trees; others that it was beneficial. If you can give us any information we would be very much pleased to receive it. The crude acid mentioned above cannot be diluted with water."

For experimental purposes, the Company was good enough to send a barrel of the 50–60 per cent. material to Mr. Thatcher for use under my direction.

Attention should be called here to the statement that the acid is insoluble in water, and that proved to be the case on experiment. It seems to involve the idea that the sap of the tree contains some solvent of the acid that takes it up and carries it into the circulation.

The cuttings made as above mentioned were turned over to Mr. Charles S. Cathcart, the chemist of the Station for analysis, and some of the thick apple bark was split so as to separate the hard outer layers on which the acid was applied from the green and sappy inner layers in which the circulation was active. There was no difficulty in getting the acid out of the painted portions—

in fact it was present in such quantity as to raise a question whether all that was put on was not actually just where it was put. All the rest of the tests were negative. In the case of the split bark, a small quantity was obtained, which was not unexpected, because the acid stain was noticeable at a few points where it had penetrated almost the entire thickness of the bark. So far as these tests indicate, there is no appearance of the acid in the plant tissue beyond the point at which it was put on.

Some of the acid received by Mr. Thatcher was sent to me and was the material used in painting the nursery apples elsewhere reported upon. To test whether the material might be carried into the ground and get into the circulation through the roots, Mr. Thatcher applied to the surface under and around a natural apple tree three gallons of acid through a sprinkling pot, covering a surface equal to the spread of the branches. The work was done July 19th, after a heavy shower, and it was followed during the night by other showers. The tree was very scaly, had not been treated in 1906, but was painted with the others in 1907. This application killed all the vegetation beneath the tree and no new grass came up again during the season.

A Ben Davis apple, which had been acid banded in 1906, and again in 1907, received an application of 2½ gallons of acid beneath it under the same conditions and at the same time as the other. The apples were no good last year, but this spring (1907) there was only a moderate infestation.

Another Ben Davis, much like the preceding, received two gallons of the acid on the surface beneath it, and this like the preceding killed all vegetation that it touched.

A large Bartlett Pear, acid treated in 1906 and 1907 had an application of 1½ gallons on the surface beneath it. It is a tree only moderately infested now; but on which two years ago the infestation was very severe.

Finally, to test for injury, a Bottle Greening, about 10 inches in diameter, was painted near the butt, with as much acid as it would take up. This had also been treated two years and was yet very scaly.

A large part of the remaining material was distributed by Mr.

Thatcher to neighbors who wished to use it, and were willing to report upon results later.

I went over part of this area again in August to note progress, and finally, on September 21st, to determine results.

The natural apple tree was so much injured by the scale that it is probably doomed. Neither the banding of early spring nor the application of the material to the soil had caused any apparent injury to the tree. Nothing appeared in its condition that was not fully accounted for by the scale infestation, which was very bad. Larvæ and recent sets were present in great numbers.

The two Ben Davis apples receiving respectively 2½ and 2 gallons seemed to be neither better nor worse for the acid treatment. The trees were very badly infested, and there was plenty of living scale, larvæ and recent sets on fruits as well as on the trees themselves. Yet Mr. Thatcher assures me that the trees are in better condition than they were in 1905.

The Bartlett Pear tree was in a very decent condition. There was no fruit, but such as had been taken off had been practically clean. There was plenty of scale on the tree, yet not enough to cause apprehension of harm to it. The fruit on this tree I am told was very badly infested in 1905.

The Bottle Greening treated to a soaking band was still alive, but very scaly and it looked badly. The acid had soaked completely through the bark, had penetrated the sap layer, and the entire bark was dead, completely or nearly so around the trunk. It demonstrates that an excessive application will kill even an old tree and that the acid kills as far as it penetrates. This same feature was apparent on a number of other trees, although on none of them was there anything like a girdling. Nevertheless, so far as the acid penetrates obviously, it kills; that was the record everywhere. There were many trees however in which there was no appearance of discoloration below the surface layer, and where there was no sign of injury of any kind.

Taking the apple and pear orchard as a whole it was not in a bad condition. On some trees the fruit was almost clean; on others it was badly infested; on none of them was it unsaleable. Red apples appeared to be on the whole in worse condition than green apples, and in all cases the orchard was said by Mr.

Thatcher to be in much better condition than in 1905. The pear trees were in about the same case as the apples, and whilst living scale in all stages could be found on all of them, the infestation was not bad on any. That the pear trees had been much worse infested in the past their present condition showed.

In the dehorned peach orchard conditions were excellent. The new growth was vigorous, of good color and clean. There had been only a small crop, most of which was off; what remained was very fine in size, color and flavor. On some trees not a scale could be found, and this was generally the case where the cutting back had been severe and where all the branches had been cut. On some trees some old branches had been allowed to remain, and on some of these the scale has made a fresh start on the new wood; but in all cases there was only a little. On only a few trees on which considerable old wood was allowed to remain was there any serious present infestation and these trees were marked to be taken out or severely cut.

As a whole this orchard is in such condition that it might safely be allowed to go another year without any treatment, and would even mature a crop in 1909 without the loss of any trees.

The peach orchard between Flemington and Cherryville, which had been banded with acid and also sprayed with lime and sulphur was found to be in very nice and clean condition. There had been a very fair crop of fruit and while there was some scale scattered throughout the orchard, there was nothing that endangered any of the trees for this year, and most of them might be considered safe for a year to come.

The apple orchard belonging to the same owner was in quite a different case. The substitution of the acid for the lime had not checked the development of scale in the least and trees that were looking fairly in July were now in a hopeless condition. On other trees—notably Baldwins—the fruit was so badly infested as to be unsaleable. There was not a particle of evidence that the slightest benefit had been derived from the acid. Here also I found that in many cases the acid had penetrated deeply into the bark, and that some trees were partially girdled.

The one peach orchard which had been banded with acid only and had no other treatment of any kind was now in a horribly

scaly condition. Some of the trees were yellow with crawling larvæ or white with recent sets. So bad were conditions indeed, that I advised the owner that if he did not take immediate measures of some kind his trees would not survive the winter. The infestation was not equally bad throughout the orchard, and some trees would probably stand another season; but as a whole the trees were just about as scaly as they could be and live the season out. This is the only case of infested trees where only acid was relied upon, and it has failed here, absolutely. It will be claimed that not enough acid was used, and there is no doubt that the quantity applied was small; but the failure was so uniform and absolute that it is a distinct question whether even double the dose would have been more effective. These trees are of just the age when the scale is hardest on them—*i. e.*, ready to bear the first heavy crop; and if they are not absolutely destroyed by scale next year, will have the bark on all the old wood in about the condition that Mr. Thatcher's trees were in when they were cut back.

The difference in condition between this orchard and the Thatcher orchard is so great that it at once raises the question whether there was not some factor in the one case that was not present in the other and which was responsible for the difference. My explanation of the matter is that the Thatcher orchard became infested more slowly. It was older when the scale became serious, had already born quite well and the wood and bark were altogether more mature. The bark on trunks and all the old wood toughened and became cracked, rough and scaly, and so hard and lifeless that it furnished nothing for the insects if they actually succeeded in setting on it. When Mr. Thatcher cut back, he cut off practically all the live scale on the tree, and what little he left of the old wood was not much infested and not much suited to propagate scale rapidly. There is every probability that had he not applied any acid at all, his trees would be in no worse condition than they are. But there is not, unfortunately, a single untreated tree that might serve as a check.

On August 7th, Mr. Dickerson drove from Lebanon to New Germantown, visiting orchards to determine the effects of whatever treatment had been made. At Bissell he found quite a

number of trees treated with carbolic acid; but most of them had also been treated with either oil or lime and sulphur as well, so that as tests of either material they were useless. He did find some apple trees however that had been treated with acid alone, and on all of them scale was already obvious on the fruit and active on the trees. He saw these trees again in late September and it was then obvious that absolutely no good had resulted from the application. One lot of 6 peach trees in an orchard otherwise treated received only the acid, and these looked poorer than any of the other trees.

At New Germantown spraying was general, "Scalecide" and lime and sulphur both being in use. Some carbolic acid has been used, but in almost all cases was not alone relied upon; it was put as an additional guardian on trees otherwise treated. Some old apple trees had been painted, however, and these had had no other treatment, yet were in much better condition than they were two years ago. The owners believe the acid responsible for the improvement. It was pointed out by others, however, that many other old apples in the vicinity which were very scaly three years ago, and apparently dying, had taken a new start without any treatment whatever, and these also Mr. Dickerson found to be now relatively free from infestation.

Near Lebanon one peach orchard of five thousand trees was found in which 60 trees were treated with carbolic acid in addition to the "Scalecide" treatment which all received. These acid banded trees had been decidedly injured; they were stunted and unhealthy in appearance and altogether much poorer than the rest of the orchard.

August 22d, was spent at Pattenburg and vicinity by Mr. Dickerson, and this vicinity seems to be the stronghold of the acid faith.

The first orchard visited was of large, bearing apple trees. It was treated before the trees started by painting a band two or three feet wide about the trunk, first scraping to remove loose bark. On some of the trees a few limbs during the last year or so have been killed by the scale; but on the whole the trees had a very good color, and some were bearing considerable fruit. Some—Northern Spy, Baldwin, Crab, etc.—showed plenty of live scale

on apples, leaves and twigs. Some trees appear never to have been scaly to any extent, and of course they are in good condition now.

A second, somewhat smaller orchard of the same age, belonging to the same owner, and treated in the same manner, was found to be practically clean. There were only three trees found showing any amount of scale, and there was no indication that the trees now clean had ever been infested.

A third place had a mixed lot of trees—plum, pear, apple, etc. These had been treated for two years, with carbolic acid, in the spring, a band about three feet wide being painted around the trunk. Of the plums one row of Abundance trees was left. These trees, the owner said, were very scaly a year or so ago. Now they show only a small amount of scale on the new growth. A couple of rows of pear trees, more or less scaly a year or so ago, were now in much the same condition as the plum, and showed only a small amount of scale on the new growth. A large "early" apple tree, treated in the same way, showed a great amount of scale on some of the lower limbs.

The fourth place was in town, and the treated trees were around the house—old plum and pear trees. They had been treated by pouring about a quart of the acid in the crotch of the trees and letting it run down the trunk. It had not appeared to harm the trees, which were yet scaly, though not bad. There was scale on the pear fruit, but last year it was said the fruit was so badly infested as to be unusable.

The fifth orchard was bearing peach, and this had been banded with acid and sprayed with a mechanical mixture of oil and water. The result was good. Some apple trees, fifteen years old, had been painted with the acid only, a band a foot or two wide being put on in early spring. These trees showed a large amount of infestation.

A sixth orchard was not visited, but the owner was seen in town. He said he had banded his trees with acid in spring, and they still had plenty of scale; but he believed they would show up better next year.

A seventh orchard was visited, but contained no acid-treated trees.

It should be noted that both of Mr. Dickerson's trips were made before the heavy broods of the season appeared, and that what was only a slight or moderate infestation in August might easily be a serious matter in September.

Altogether this account presents the best possible statement in behalf of the acid. In my account of the scale conditions, I have called attention to the fact that conditions this year did not favor the scale at all, and that, even where no treatments at all had been made, great improvements were noted. So far as the older apples were concerned, there is not a particle of evidence in any case that any real improvement had been caused by the acid. There is very definite evidence that it is quite possible to kill apple trees, ten inches in diameter, by an overdose, and that young apples cannot be safely treated at all.

As for peach, there are only two large treated orchards known to me. In one case the acid failed absolutely, in the other the apparent success may not be due to the acid only, or at all. Only a few plum trees have been treated, and all of these have improved; but the trees were too few in number to serve as bases for definite conclusions. So the number of pears treated is too small to warrant conclusions. In no instance was a tree entirely freed from scale, and whether in a more normal season the surviving remnant would not have become more obvious is a question.

At all events I would not advise anyone to use the acid as a sole dependence in a badly infested orchard. I do advise, as an experiment, in an orchard where trees are so slightly infested as to be in no danger, that from the general treatment a row be left untreated, and another treated with the acid. The results of a number of such tests will soon furnish conclusive evidence as to the value of the material. Paint a band two feet wide, and put on as much as is readily absorbed by the surface; when it begins to run off, stop.

Avenarius Carbolineum.

This material was brought to my notice by the American agents of the German manufacturers, with the statement that it had been successfully employed against a variety of insects by painting the

trunks, which seemed to render the tree proof against insect attack, caused it to grow more vigorously, etc. In other words, the claims made for the carbolic acid were duplicated; and yet not exactly, for here it was recommended to paint trunks and branches, and it was rather as a destroyer of cankers and insects, and as a healer, that it was proposed. The material was received too late to permit of any real tests, and only four small apple trees were treated as described in the records of the nursery trees. The results were altogether negative, but not conclusive.

It seems, however, that this is not as I was at first inclined to consider it, an attempt to make capital out of a few cases of apparent results, but that Carbolineum has been rather carefully tested for a series of years in Germany, and notably at the Royal Institute for wine, fruit and garden culture at Geisenheim a. Rh., an institution that I visited in 1900, and which ranks as one of the best of the German Experiment Stations. In their reports for 1905 and 1906 this material is favorably referred to, and was used as a destructive agent against the Pear Scale, which is almost as dangerous locally as the San José Scale is with us. But there is no pretence that the material acts through the sap; it is simply a very effective contact poison, and kills exactly as do the petroleum oils.

Applied undiluted on apple trees of various kinds in April so as to cover completely, no harm had been done a year afterward. Painted on canker sores and on sore and cracked areas it checked the spread of the disease, caused the formation of new bark, and seemed to destroy the morbific organisms.

Applied on pear trees it destroyed the scales infesting them, and induced a vigorous healthy growth. Pictures illustrating treated and untreated trees show a remarkable difference in favor of those that were treated. Just how this result was produced is not stated, but it is strictly analogous to the results noted in some cases from an application of crude petroleum on similar trees, or from the application of lime and sulphur on peach trees. It seems to be a fungicide as well as insecticide, and merits further experimental use.

The material is one of the products of coal-tar distillation, and contains a large percentage of phenol; it is a close relation of car-

bolic acid in other words. It is not directly miscible with water but may be rendered so by using an alkali, *e. g.*, soda, or making an emulsion with soap suds. As to its effective strength nothing is known save that undiluted it is fatal to almost all kinds of insect life. It is equally fatal to growing plant life, and must not be used on foliage of any kind.

Nothing can be done at present except to call attention to the material as one meriting further trial.

Arsenate of Lead.

During the past year a number of new brands of this material have been placed on the market by chemical companies like the Grasselli Company, and paint-makers like the Sherwin-Williams Company. Analyses of several of the brands used in New Jersey were published in the report for 1906. None of the new brands received were analyzed at this Station, but Mr. John P. Street who made the analyses for me last year continued the same kind of work at the Connecticut Station, and found in all the brands examined practically the same range of percentage of actual arsenic reported by me, *i. e.*, from 11% to 21%.

The only experiments made during the season of 1907 were to determine the effect on foliage of the Vreeland arsenate of lead which contains the largest percentage of arsenious oxid, and is made by a method entirely different from the other brands. It was used on all the ordinary orchard trees, peach, apples, pear cherry, quince, and on Japanese walnut, at rates far in excess of requirements and without causing even the slightest injury in any case.

As this material costs no more than the other brands, and contains from 6% to 10% more actual arsenious oxid, this would seem to be the cheapest and most effective material to use. Two and one-half pounds of this will equal one pound of Paris green and three pounds in 100 gallons of water will do the work for which four to five pounds of the other brands are required.

As a general rule five pounds of arsenate of lead should be used in 100 gallons of water until manufacturers print on their

labels the actual percentage of arsenious oxid contained in their material. The advantages may be again stated as harmless to foliage of all kinds at any strength, great adhesiveness or lasting qualities, remains in suspension for a longer time than any other arsenical insecticide preparation.

Arsenate of Iron.

From Dr. Fred. P. Dewey of Washington, D. C., I received about 100 pounds of this material, said to be a by-product in ore preparation, and to contain about 45% of arsenious oxid or arsenic. No analysis of the material was made at the Station, but, as I know Dr. Dewey as a reliable chemist, I accepted his statement of the composition of the material and that it contained very little, if any, water-soluble arsenic.

Trial of the material was made by Mr. Dickerson early in July on some elm trees infested by larvæ of the elm-leaf beetle, on the basis of an equivalent of one pound of Paris green in 100 gallons of water. Rating the arsenic in Paris green at 55%, it required 1¼ pounds of the arsenate of iron to 100 gallons of water, and at that rate it was applied July 17th, weather warm and fair. The solution when mixed was green in color, and the material remained in suspension fairly well only. Some sediment remained in the spraying tank despite agitation during application.

There was a heavy rain on the afternoon of July 18th, and a lighter precipitation on the 20th, so that on the 22d there was little trace of the material remaining. There was no trace of injury to the foliage at that time, but the larvæ had disappeared. The conclusion was that the material was effective against the insects and harmless to foliage at the strength employed. No injury developed later on the sprayed foliage.

A second application was made of this material in competition with arsenate of lead against the army worm on the College Farm in July. Details of this application are given in the account of the appearance of this insect on the College Farm, and only the conclusion need be referred to here. No harm was caused to foliage and, as against the caterpillars, it was satis-

factorily effective—quite as much so as the arsenate of lead. It was intended to use the material further on field crops on the College Farm, but opportunity did not serve.

From what has been done, it appears that arsenate of iron is worthy a careful test, and promises well. It is not yet regularly on the market and there is no price for it. Further experiments may be postponed until there is a commercial preparation in hand, or offered to the agricultural public.

Arsenate of Lime.

This is a second material received from Dr. Dewey, and was said to contain 48 per cent. of actual arsenic, no appreciable portion of it water soluble.

This was tried in competition with the arsenate of iron at the same time and on the same basis; requiring 1⅛ pounds to 100 gallons to equal 1 pound of Paris green.

It was white in the solution, very fine, and remained in suspension very well. On the examination made on July 22d there was no appearance of injury to the foliage; but as a number of larvæ yet remained on the leaves the effect was not satisfactory. It was not to be compared in efficiency with the iron.

Combinations of arsenic and lime are well known and very easily prepared by the farmer himself. Therefore, any such material as this sent in for trial, must be offered very cheaply to make it worth while testing further. It is bound to be effective in proportion to the amount of actual arsenic contained, and safe in proportion to the completeness of combination between arsenic and lime.

Arsenate of Barium.

This is the third of the materials sent in for trial by Dr. Dewey, and was said to contain only 30 per cent. of arsenic. Tested in comparison with the arsenates of iron and lime, and at the same time; it required 1 4-5 pounds in 100 gallons of water to bring it up to the same strength as the others.

It was white in solution, coarser than either of the others and remained in suspension very poorly. It was impossible to spray without a sediment.

On July 22d the treated foliage was spotted and showed undoubted marks of injury. This, and the fact that it had harmed the larvæ less than it did the leaves discouraged further trial.

EXPLANATION OF PLATES AND FIGURES.

PLATE FIGURE 1.

Placing tarred paper disks on cabbage plants. From an original photo.

PLATE FIGURE 2.

The short unbroken row of cabbages shows the effect of the tarred disks; the other rows were otherwise treated. From an original photo.

PLATE FIGURE 3.

Work of cabbage maggot in wild radish plants in October. From an original photo.

FIGURE 4.

A combined furnace and kettle, made by the Philadelphia Farmers' Supply Company. Electrotype by courtesy of the company.

REPORT OF THE MOSQUITO WORK IN 1907.

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Report of the Mosquito Work in 1907.

BY JOHN B. SMITH, SC. D.

The work of the year extending from November 1st, 1906, to October 31st, 1907, was carried on under Chapter 134 of the Laws of 1906, which went into effect on November 1st, 1906, and reads as follows:

AN ACT to provide for locating and abolishing mosquito-breeding salt-marsh areas within the State, for assistance in dealing with certain inland breeding places, and appropriating money to carry its provisions into effect.

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. It shall be the duty of the director of the State Experiment Station, by himself or through an executive officer to be appointed by him to carry out the provisions of this act, to survey or cause to be surveyed all the salt-marsh areas within the State, in such order as he may deem desirable, and to such extent as he may deem necessary, and he shall prepare or cause to be prepared a map of each section as surveyed, and shall indicate thereon all the mosquito-breeding places found on every such area, together with a memorandum of the method to be adopted in dealing with such mosquito-breeding places, and the probable cost of abolishing the same.

2. It shall be the further duty of said director, in the manner above described, to survey, at the request of the board of health of any city, town, township, borough or village within the State, to such extent as may be necessary, any fresh-water swamp or other territory suspected of breeding malarial or other mos-

quitoes, within the jurisdiction of such board, and he shall pr pare a map of such suspected area, locating upon it such mo quito-breeding places as may be discovered, and shall report upc the same as hereinafter provided in section eight of this ac Requests as hereinbefore provided for in this section may l made by any board of health within the State, upon its own m tion, and must be made upon the petition, in writing, of ten more freeholders residing within the jurisdiction of any suc board.

3. Whenever, in the course of a survey made as prescribed section one of this act, it is found that within the limits of ar city, town, borough or village there exist points or places whe salt-marsh mosquitoes breed, it shall be the duty of the direct aforesaid, through his executive officer, to notify, in writing, l personal service upon some officer, or member thereof, the boa of health within whose jurisdiction such breeding points or plac occur, of the extent and location of such breeding places, and suc notice shall be accompanied by a copy of the map prepared prescribed in section one, and of the memorandum stating tl character of the work to be done and its probable cost, al therein provided for. It shall thereupon become the duty of tl said board, within twenty days from the time at which notice served as aforesaid, to investigate the ownership, so far as asce tainable, of the territory on which the breeding places occur, ar to notify the owner or owners of such lands, if they can be four or ascertained, in such manner as other notices of such boards a served, of the facts set out in the communication from the di ector, and of the further fact that, under chapter sixty-eight the laws of one thousand eight hundred and eighty-seven, amended in chapter one hundred and nineteen of the laws of o thousand nine hundred and four, any water in which mosqui larvæ breed is a nuisance and subject to abatement as such. Sa notice shall further contain an order that the nuisance, consistir of mosquito-breeding pools, be abated within a period to be state and which shall not be more than sixty days from the date of sa notice, failing which the board would proceed to abate, in accor ance with the act and its amendments above cited.

4. In case any owner of salt-marsh lands on which mosquito-breeding places occur and upon whom notice has been served as above set out, fails or neglects to comply with the order of the board within the time limited therein, it shall be the duty of said board to proceed to abate under the powers given in section thirteen and fourteen of the act and its amendments cited in the preceding section, or, in case this is deemed inexpedient, it shall certify to the common council or other governing body of the city, town, township, borough or village the facts that such an order has been made and that it has not been complied with, and it shall request such council or other governing body to provide the money necessary to enable the board to abate such nuisance in the manner provided by law. It shall thereupon become the duty of such governing body to act upon such certificate at its next meeting and to consider the appropriation of the money necessary to abate the nuisance so certified. If it be decided that the municipality has no money available for such purpose, such decision shall be transmitted to the board of health making the certificate, which said board shall thereupon communicate such decision forthwith to the director of the Agricultural Experiment Station or his executive officer.

5. If, in the judgment of the director aforesaid, public interests will be served thereby, he may set aside out of the moneys appropriated by this act such an amount as may be necessary to abate the nuisance found existing and to abolish the mosquito-breeding places found in the municipality which has declared itself without funds available as prescribed in the preceding section. Notice that such an amount has been set aside as above described shall be given to the board of health within whose jurisdiction such mosquito-breeding places are situated, and said board shall thereupon appoint some person designated by said director or his executive officer a special inspector of said board for the sole purpose of acting in its behalf in abating the nuisance found to be existing, and all acts and work done to abate such nuisances and to abolish such breeding places shall be done in the name of and on behalf of such board of health.

6. If in the proceeding taken under section four of this act the common council or other governing body of any municipality

appropriate to the extent of fifty per centum or more of the money required to abate the nuisance and to abolish the mosquito-breeding places within its jurisdiction it shall become the duty of said director of the Agricultural Experiment Station to set aside out of the moneys herein appropriated such sum as may be necessary to complete the work, and in all cases preference shall be given, in the assignment of moneys herein appropriated to those municipalities that contribute to the work and in order of the percentage which they contribute; those contributing the highest percentage to be in all cases preferred in order.

7. In all cases where a municipality contributes fifty per centum or more of the estimated cost of abolishing the breeding places for salt-marsh mosquitoes within its jurisdiction, the work may be done by the municipality as other work is done under its direction, and the amount set aside as provided in section six may be paid to the treasurer or other disbursing officer of such municipality for use in completing the work; but no payment shall be made to such treasurer or other disbursing officer until the amount appropriated by the municipality has been actually expended, nor until a certificate has been filed by the director or his executive officer stating that the work already done is satisfactory and sufficient to obtain the desired result, and that the arrangements made for its completion are proper and can be carried out for the sum awarded.

8. In all investigations made under section two of this act the report to be made to the board of health requesting the survey shall state what mosquitoes were found in the territory complained of, whether they are local breeders or migrants from other points, and, in the case of migrants, their probable source, whether the territory in question is dangerous or a nuisance because of mosquito breeding, the character of the work necessary to abate such nuisance and abolish the breeding places, and the probable cost of the work. Said board of health must then proceed to abolish the breeding places found under the general powers of such boards, but if it shall appear that the necessary cost of the work shall equal or exceed the value of the land without increasing its taxable value, such board may apply to the director aforesaid, who may, if he deems the matter of sufficient

public interest, contribute to the cost of the necessary work, provided that not more than fifty per centum of the amount shall be contributed in any case, and not more than five hundred dollars in any one municipality.

9. All moneys contributed or set aside out of the amount appropriated in this act by the director of the Agricultural Experiment Station in accordance with its provisions shall be paid out by the Comptroller of the State upon the certificate of said director that all the conditions and requirements of this act have been complied with, and in the case provided for in section five payments shall be made to the contractor upon a statement by the person in charge of the work, as therein prescribed, attested by said director, showing the amount due and that the work has been completed in accordance with the specifications of his contract.

10. For the purpose of carrying into effect the provisions of this act, the said director of the State Agricultural Experiment Station shall have power to expend such amount of money, annually, as may be appropriated by the Legislature; *provided,* that the aggregate sum appropriated for the purposes of this act shall not exceed three hundred and fifty thousand dollars. The Comptroller of the State shall draw his warrant in payment of all bills approved by the director of the State Experiment Station, and the Treasurer of the State shall pay all warrants so drawn to the extent of the amount appropriated by the Legislature.

11. This act shall take effect November first, one thousand nine hundred and six.

Approved April 20, 1906.

Pursuant to the provisions of section 1 of said act the writer was appointed executive officer by Dr. Edward B. Voorhees, Director of State Experiment Station, for the purpose of carrying out the requirements of said act, and work was at once begun under its provisions.

In the regular appropriation bill, taking effect November 1st, 1906, the Legislature had made available for the purpose of this work the sum of $13,500. In the supplemental bill which went into effect May *21st, 1907, the further* sum of $10,000 was made

available, making a total of $23,000 to be applied to the wo during the fiscal year.

In planning out the work to be done, regard was had primari to two points: Those communities which had already expend considerable sums on their own behalf or were ready to cont bute materially to the work, were entitled to be first considere Those areas of salt marsh whose mosquito output affected t largest population should be dealt with as soon as possible. As happened there was no conflict between these two purposes, t cause Newark and Elizabeth, which had already made lar expenditures, were also large centres of population, and Jers City, which forms part of the same general centre, provid sufficient funds for all the work in its own territory.

Surveys of the Elizabeth and Jersey City marshes had be already made under a previous law, and formal notices we served upon the boards of health of both cities soon after t new law went into effect. A copy of the notice served upon t Elizabeth board of health will illustrate the form that has be uniformly followed in all subsequent proceedings

"GENTLEMEN—Please take notice, that in the course of a su vey, made in accordance with section 1 of Chapter 134 of t Laws of 1906, the following salt marsh mosquito breeding are were found within the limits of the city of Elizabeth, and with your jurisdiction, as shown in the maps hereto attached. The areas are located on said maps by lettered sections, more partic larly described as follows:

"*Section A* is a triangular area, bounded on the north by spur of the Newark branch of the Central Railroad of New J sey, which runs through Great island, on the east by the sa Newark branch of the said railroad, and on the west by Woo ruff creek and Great ditch.

"*Section B* is a long, narrow area lying between Woodr creek and Great ditch on the east, the highland on the west, t Newark branch of said Central railroad on the south, and t spur of this railroad on the north.

"*Section C* is an arrow-shaped area lying between Woodr creek and a division of this creek on the east, the highland the west, and said spur of the Newark branch of the Cent railroad on the south.

"*Section D* is an irregular stretch of land, bounded by Woodruff creek on the north and west, by the Newark branch of said Central railroad on the east, and by a spur of said railroad on the south.

"*Section E* is the area bounded by Bound creek on the east, the highland and a branch of Woodruff creek on the west, and Woodruff creek on the south.

"*Section F* is the small triangular area bounded on the north by a wagon road extending into the marsh, on the east and south by Oyster creek, and on the west by said Newark branch of the Central railroad.

"*Section G* is a large area bounded by Bound creek on the north, by Newark bay on the east, by the Newark branch of said Central railroad on the west, and by Oyster creek and said wagon road on the south.

"*Section H* is a triangular area between Oyster creek on the north and west, Newark bay on the east, and the area already drained on the south.

"*Section I* is an area bounded on the south by the Elizabeth river, on the west by the New York and Long Branch railroad, and on the north by the Highland: this latter area being part of that already drained along the Elizabeth river, and this needs only a few ditches to perfect the drainage.

"You are further notified that the character of the work to be done is the placing of deep ditches of a width shown on said maps at such intervals as may be necessary to drain off the surface water, supplemented by filling the deeper holes with the sods taken from the ditches. That the total area to be drained is approximately 2,210 acres, and that the probable cost of the work required to drain the entire areas above mentioned, so as to dispose of all the mosquito breeding, is the sum of five thousand three hundred dollars ($5,300).

"This notice is served upon your body pursuant to the requirements of section 3 of said Chapter 134 of the Laws of 1906 aforesaid."

The descriptive portion is, of course, different in each case; but all the other features are identical, and in every case a printed copy of the law and a blue print of the survey and ditching plan accompanied the notice.

The notices to owners served by the various boards of health differed somewhat in form and were usually drawn by the Coun-

sel of such boards. That served by Jersey City is shown on figur 1, made from one of the posted notices on the marsh.

The last paragraph of this notice was usually omitted in mun cipalities that had not made any appropriation for the work, an the description of the location of the land varied in accordanc with local requirements. The essential features, however, th notice that mosquito breeding places existed, that they wer nuisances, the order to abate and the notice that in case of failur the work would be done by the Board were the same in all case

It proved unexpectedly difficult in some instances to ascertai the names of the owner of marsh lands, and so notices wer posted on the marsh itself. In one case the lands were not eve listed for taxation and so, in order to reach all parties, the notice were published in the local newspaper as well as posted.

At the expiration of the time limit, notice was usually give to the writer, formally or informally, of the fact that nothing ha been done, and the local municipal authorities were formally r quested to contribute or provide for the work to be done.

The cities of Jersey City, Rahway and Long Branch paid fc all the work required within their own limits. The City of Eliz beth contributed the sum of $1,000 toward the work done th year, but had in previous years expended sums making an equiv lent of about 50 per cent. of the entire cost of the work dor within its own limits.

After all the preliminary requirements of the law had bee complied with, and the Director had approved by setting aside sufficient sum to do the necessary work, specifications were draw and bids were asked for from contractors fitted to do mar work. In the Jersey City and Long Branch work bids we advertised for, and in Jersey City the specifications and ma were examined by a number of contractors for other city wor As soon as they learned that special tools and apparatus w needed, and that they would come into competition with speci machinery, they refused to enter the contest, and practically a contests narrowed down to

Mr. Jesse P. Manahan, Monmouth Beach, N. J.

Mr. Eugene Winship, Staten Island, N. Y.

Mr. Edwin M. Skinner, Staten Island, N. Y.

Figure II.
The Skinner ditching spade on the Woodbridge marsh.

Mr. Harry Wolfe, New York city, N. Y.

The Monmouth Contracting Co., Atlantic Highlands, N. J.

Mr. H. H. Judson, New York city, N. Y.

Mr. Jesse P. Manahan had secured control of the True ditcher, first by hire and afterwards by purchase; was well equipped with bog saws and spades; had the experience of work done on the Shrewsbury and Newark marshes to his credit, and was financially able to carry all the work. Most of the contracts were awarded to him; they were always well performed, and practically within the time limits of the contracts.

Messrs. Winship and Wolfe were at various periods associated with Mr. Skinner, and relied at first upon a ditching machine invented by Mr. Skinner. This machine, as a matter of fact, never got on the marsh for practical work at any period of the fiscal year, and is yet really untried. The Linden contract was originally awarded to Mr. Skinner as the lowest bidder, but he was unable to secure the required bond and it went, therefore, to the next lowest bidder who assumed it at the amount bid by Mr. Skinner. The Woodbridge contract was awarded to Messrs. Skinner and Wolfe as the lowest bidders, and they qualified in due course. They failed to make a start, however, until so late that compliance with their contract became impossible, and, as that date was so late that it would have been impossible to have it finished within the fiscal year by any one else, after consultation with the office of the Attorney-General, the time limit to the contract was waived and they were allowed to go ahead. The work done by this firm is good, and they have in service an excellent spade of special, patented design, figured in this report, which enables them to make a clean, straight ditch which does excellent service. Whether their machine will ever prove practical is another question.

The other bidders, depending upon other tools or hand labor only, soon dropped out, unable to compete with the contractors just mentioned.

The work to be done in Long Beach township was somewhat in the nature of an experiment, and, as the machines here would be of little service, two other contractors were invited to bid:

Mr. Benjamin S. Cox, Beach Haven, N. J.

Mr. John Bell, Haddonfield, N. J.

The character and remuneration to be expected failed to appeal to these gentlemen, and they declined to enter into the competition.

The following copy of specifications, prepared for the Linden township work, is an example of all those used. Each locality offers some little peculiarities that make slight changes imperative, but the essential requirements were in all cases the same.

Specifications for Drainage Work Required on the Salt Marshes in Linden Township.

1. The contractor must undertake for a lump sum to drain, by ditches of such size and depth as may be needed, the salt-marsh area shown on a map prepared by the executive officer of the Director of the State Experiment Station, in accordance with Chapter 134 of the Laws of 1906, and on file in the office of the Board of Health of the Township of Linden, at the Township Clerk's office in the town of Linden. But small, deep holes between the lateral ditches shown on said map, which do not drain with sufficient rapidity, must be filled with material taken from the ditches, and larger pools or holes may be either filled or drained by a sufficient spur ditch into the nearest regular ditch.

2. All ditches are to be 30 inches in depth, except where a greater depth is required on the map already referred to. They shall have smooth sides or walls, and shall be even in course so as to prevent clogging or interruption of flow. They shall be within two inches as wide at bottom as at top, and the bottom shall be level so that the water may not lie dead in pools or pockets at any time, even if to obtain such level it may be necessary in carrying it through an elevation in the marsh to make it deeper than specified for the general course of the ditch.

3. All sods shall be removed at least three (3) feet away from all ditches, to prevent the bank from caving in and the sods from falling back into the ditches.

4. All the ditches marked on said map shall be cut, and shall be of the width and depth marked on said map. The location of such ditches as laid down on said map is approximately correct,

and the length of such ditches, as a whole, is also approximately correct; but where such ditches are drawn between points to be connected they shall be between these points as they are on the marsh, and not as they may be laid down on the maps. But no more than 14,500 feet of cleaning out old ditches and 251,000 feet of new ditches shall be required of the contractor, except such spur or branch ditches as may be needed, as specified under Section 1. Attached hereto is a specific statement of the work required, as measured out on said map.

5. All ditches will be located, lined out, and the widths and depths indicated for the contractor by an inspector appointed for that purpose, who shall have general oversight of the work and shall, whenever requested by the contractor, certify the proportion of work done. Such inspector shall have no authority over the contractor or his employees in his practical carrying out of the contract and digging the ditches, but he shall call the attention of the contractor to any departure from the true meaning of these specifications which may delay or prevent the giving of a certificate for satisfactory work done. In case of any difference between the contractor and the inspector the contractor may appeal to the executive officer appointed under the law cited in the first section, and his decision shall be final.

6. Bidders should satisfy themselves by personal inspection, or in such other way as they may prefer as to the character, extent and location of the proposed work, of the general accuracy of the said map and as to whether the character of the marsh to be drained is such as to permit of the kind of operation by means of which they propose to carry on the work. No claims for compensation other than specified in the contract will be considered, within the limits of the areas to be drained or within the general scheme of drainage as laid down on said map.

7. Contractors must furnish all tools, machinery, material and labor required to do the work in a satisfactory manner, and must agree to complete the work on or before the 1st day of September, 1907. In case the work is not completed on the date mentioned, the contractor may be declared in default and the remainder of the work to be done will then be completed under the direction of the Board of Health of the township of Linden, and the con-

tractor shall be liable for any loss sustained by any difference between the contract price and the price actually paid to complete the work.

8. Payments will be made as follows: When one fourth of the work is satisfactorily completed a certificate to that effect will be given by the inspector, and this may be presented by the contractor to the executive officer who will thereupon prepare such bills and vouchers as are necessary to secure payment to the contractor of one fourth the contract price. When one half of the work is satisfactorily completed a similar certificate will be given and bills to the amount of a second one fourth of the contract price will be prepared in the same way. When three-fourths of the work shall have been completed, one third of the remaining contract price will be certified and paid in the same way, and when the whole of the work shall have been satisfactorily completed and a certificate to that effect is in hand, the whole of the balance will be certified for payment upon the presentation of proof by the contractor that there are no outstanding claims upon him for material or labor or claims for damages caused by the contractor which might be made the subject of a lien upon the land on which the work is done or a charge against the municipality within which it is located; but this is not to apply to any claim for damage alleged to be caused by following out the terms of these specifications.

9. The contractor shall pay to the inspector the sum of $25.00 for each certificate which entitles him to a payment, or a total of $100.00 in all, and this amount should be included in the estimate of the cost of the work to be done.

10. The person or persons to whom the contract shall be awarded will be required to give a bond conditioned for the faithful performance of the contract, in the sum of $1,000.00, with such sureties as shall be satisfactory to the executive officer above mentioned.

11. The right to reject any and all bids is reserved to the executive officer if he shall not consider them satisfactory.

The contracts also, were uniform in tenor throughout, and that for the Linden Township work may serve as an example of all of them.

"This agreement, made this sixth day of July, 1907, between John B. Smith as Executive Officer appointed by the Director of the Agricultural Experiment Station to carry out the provisions of Chapter 134 of the Laws of 1906, acting on behalf of the Board of Health of the Township of Linden, party of the first part, and Jesse P. Manahan of Monmouth Beach, New Jersey, Contractor, party of the second part. Witnesseth—

First: The party of the second part in consideration of the agreements of the party of the first part hereby undertakes and agrees for the sum of three thousand, six hundred and fifty dollars $3,650.00) to ditch, fill and drain so as to free from mosquito breeding pools all that area of salt marsh territory situate, lying and being within the Township of Linden, as laid down on a map now on file in the office of the Board of Health of said Township and in accordance with the specifications for such drainage also on file; said map and specifications, copies of which are hereto annexed, being made part of this contract and evidence of the extent and character of this undertaking and agreement.

Second: The said party of the second part agrees to dig all the ditches as laid down on said map, of the width and depth mentioned on said map and specifications, and as described in paragraph 2 of such specifications. He further agrees to remove all sods as required in paragraph three of such specifications: except as special permission may be given by the party of the first part for long sod strips cut by machine and not needed for filling. He further agrees to conform to the directions of the Inspector to be appointed as set out in said specifications in all points not counter to their true intent and meaning, and he agrees to pay said Inspector the sum of $100.00 for his services

Third: The party of the second part further agrees to complete the entire work laid out on said map and described in said specifications on or before the 1st day of September which will be in the year 1907.

Fourth: And in default or in case of his failure to complete the work above described within the period above limited, said party of the second part hereby agrees to forfeit his right to complete such work under this contract and to receive compensation therefor and agrees that in case of such failure the party of the

first part hereto shall have the right to declare this contract void and of no further effect, and he agrees that such party of the first part shall have the right to complete the work under his own direction, and said party of the second part will hold himself liable for any difference between the amount for which he hereby agrees to do the work and the sum which may be actually paid to complete the work; but such liability shall not exceed the sum of one thousand dollars ($1,000.00).

Fifth: Said party of the second part further agrees to do the work required in this contract in a good and workman-like manner according to the true intent and meaning hereof, and he will hold the party of the first part free and harmless from all claims or liability for material, supplies or labor employed in said work, and from all liability for damages due to his own acts or those of his agents or employes, but not from liability incurred through following out any directions given by the party of the first part or his agents.

Sixth: The party of the first part, in consideration of the above undertakings and agreements, agrees on his part to secure to the party of the second part or his assigns, the just and full sum of three thousand, six hundred and fifty dollars (3,650.00), as prescribed in Chapter 134 of the Laws of 1906 aforesaid, and he agrees to prepare all necessary certificates, vouchers and papers required to procure such payment as follows: The sum of nine hundred and twelve dollars and fifty cents ($912.50), or one-fourth of the contract price upon presentation of a certificate from the Inspector appointed as hereinafter described, that one-fourth of the work is satisfactorily completed; the further sum of nine hundred and twelve dollars and fifty cents ($912.50), making one-half the contract price, upon presentation of a certificate from such Inspector that one-half of the work is satisfactorily completed; the further sum of six hundred and eight dollars and thirty-three cents ($608.33), or one-third of the remainder of the contract price on presentation of a certificate that three-fourths of the work has been satisfactorily completed, and the sum of one thousand, two hundred and sixteen dollars and sixty-seven cents ($1,216.67), completing the contract price upon presentation of a certificate that the work has been fully completed, and proof that

there are no outstanding claims for work, supplies or material of any kind which might be made the subject of a claim against the party of the first part or a lien upon the land upon which the work is done.

Seventh: The party of the first part further agrees to secure the appointment of an inspector, whose duty it shall be to lay out for the party of the second part all the ditches that are to be dug, and to specify their width and depth, subject to the limitations of the specifications. Such inspector shall also point out where filling or spur ditches are needed and shall advise the contractor whenever required to do so; but he shall exercise no authority over the employes of the contractor, nor shall he be required to act as a foreman or to direct the workmen except as already provided. Said inspector shall also certify at any time when requested by the contractor the proportion of work that has been actually and satisfactorily completed.

In witness whereof the parties hereto have hereunto and to a counterpart hereof set their hands the day and year first above written."

The contracts that were made under the supplemental bill were all first submitted to the Attorney-General's office for approval as to form, and then to the Governor for his approval, as required by the terms of the said law. The approved contracts were filed in the office of the Comptroller, and payments were made directly to the contractors, in all cases, upon the certificates given as required in the law under which the work was done.

In the order of time the following work was done under the provisions of the law, for the amounts specified:

Elizabeth (City paid $1,000),	$5,300.00
Jersey City (City paid all),	2,100.00
Linden Township,	3,650.00
Sayreville Township,	525.00
Raritan Township,	3,475.00
Rahway (City paid all),	200.00
Long Beach, south of Beach Haven,	3,100.00
Roosevelt Borough,	1,400.00
Newark addition,	250.00
Woodbridge Township,	2,500.00

Long Branch (City paid all),	180.00
Middletown Township,	200.00
A total of,	$22,880.00
of which the municipalities paid,	3,480.00
and the State,	$19,400.00
at an expense for administration of,	4,100.00
Balancing the appropriation of,	$23,500.00

As to the areas embraced in these marshes and the amount c ditching required, the following statement will give informatior

	Area in Acres.	Feet of Ditchin
Elizabeth,	2,500	366,000
Jersey City,	640	113,500
Linden Township,	1,936	264,812
Sayreville Township,	538	26,500
Raritan Township,	1,456	168,600
Rahway,	110	10,312
Long Beach Township,	1,472	248,100
Roosevelt Borough,	640	90,100
Newark addition,		66,800
Woodbridge Township,	1,616	145,100
Long Branch,	30	3,000
Middletown Township,	13	2,700
Total,	10,951	1,505,524

Of this ditching 82,522 feet were old, existing channels cleane and deepened to accord with our requirements; 8,850 feet were feet wide and 3 feet deep; 5,680 feet were 20 inches wide and 3 inches deep, and the balance of 1,408,472 feet is 10 inches wid and approximately 30 inches deep.

The work done in previous years covers 3,500 acres of mars in the City of Newark, with 360,000 feet of ditches; over 100,00 feet of ditches put in the Elizabeth marshes included in the acr age above given, and about 250,000 feet of ditching on approx mately 1,400 acres of marsh area on both sides of the Shrews bury river

This gives a grand total of 2,215,524 feet of ditches on 15,85 acres of salt marsh; not at all a bad record for work done unde adverse conditions against almost constant opposition and unde

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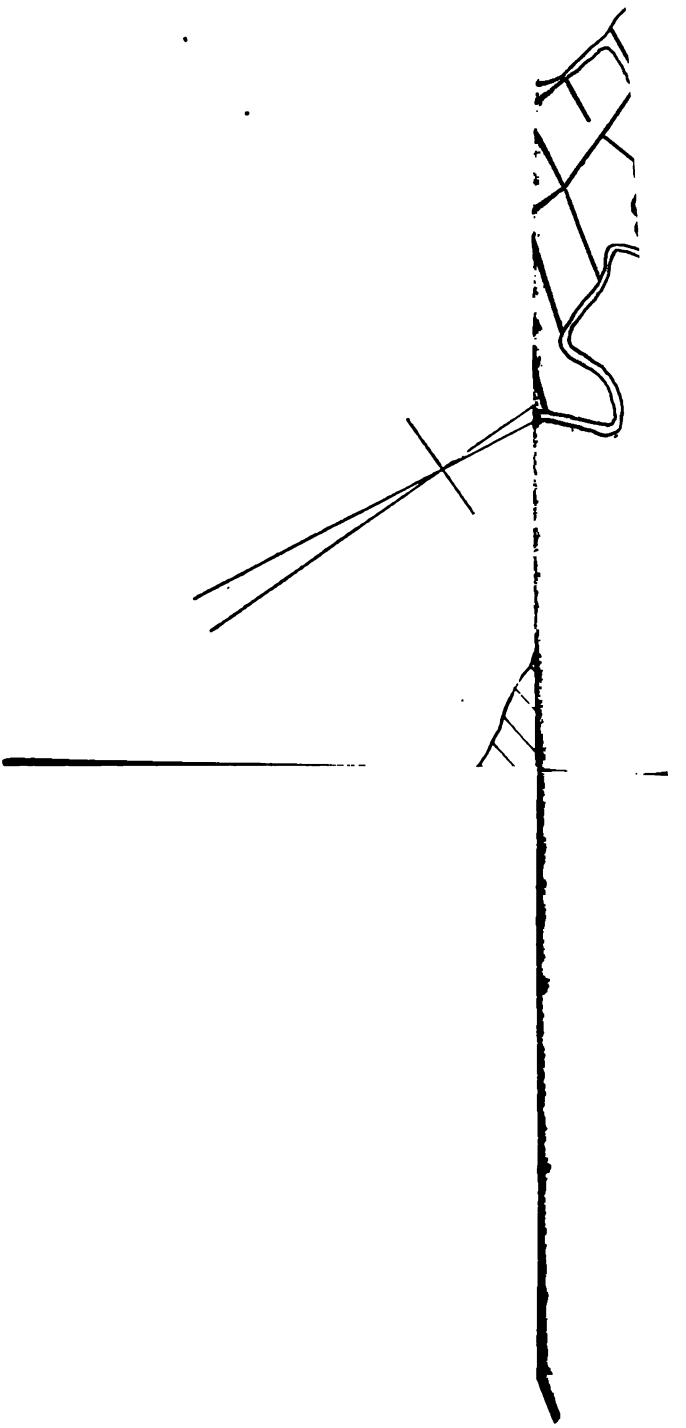

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Elizabeth.

In the Report for 1906 will be found a statement of the work done on the Elizabeth marshes up to the end of the season of that year, and also of the contributions made by the city and the State under the preceding laws. The willingness of the city to do all that lay within its ability and the amount of the expenditures already made as well as the large number of inhabitants directly affected, entitled that community to early consideration under the new law. Careful surveys and maps had been made, and as soon as the law went into effect the necessary formal notices were served to gain jurisdiction. In this work the office had the cordial and effective co-operation of the Elizabeth board of health, and especially of its health officer, Mr. Louis J. Richards, to whom special acknowledgements must be made for aid and information throughout.

Bids were asked for in due course, and Mr. Jesse P. Manahan of Monmouth Beach, proved to be the lowest bidder, for $5,300; that being the amount that we had estimated would be required. The contract was executed December 6th, 1906, and work was begun under it immediately.

After due consideration of the subject it seemed as if it would be fair to require the city of Elizabeth to contribute $1,000 toward the cost of the work, which would then divide the expense of the entire drainage almost evenly between the State and the city—the work of the previous years being figured into this account. I therefore, recommended that $4,300 be set aside out of the appropriation made under the law, and the director in accordance with this recommendation, did set aside that sum of money on condition that the city of Elizabeth provide for the balance of $1,000 required to complete the contract. That condition was fulfilled in due course.

The work on the Elizabeth marshes was unusually complicated. The right of way of the Newark branch of the Central Railroad of New Jersey passes directly through the marsh be-

tween the bay and the highland, without break from Bour creek to great Ditch at Elizabethport, and the entire area b tween the highland and the railroad was water-logged. The had been a ditch parallel to the embankment at one time, on bo sides of the road, more or less continuous and affective; b these ditches had become blocked and on the west the railro had itself blocked off a long section by putting in a "Y" and spur toward Great Island. Cutting through the railroad e bankment was out of question, so it became necessary to car all the water on this immense marsh area into Bound cre which was abundantly able to take it, or into Great Ditch, whi was utterly inadequate as it then stood. A glance at the ma which is presented herewith, will make this condition clear.

So soft and water-logged had the meadow become in t course of time that any attempt to ditch as it stood would ha resulted in almost inevitable failure.

The winter here proved an ally by putting the surface in condition to support the workmen, and during every moder spell of weather the creeks were cleaned and deepened and t large ditches were put in. The result was, that as the spri came in, the water drained off more completely than for ye back, and the surface became firm enough to hold the machir in some sections at least.

This winter work was really very difficult, very wearing the men and very expensive; the frost was often from 6 to inches below the surface, and tools as well as men suffer Through it all, in cold and storm, Mr. Brehme directed and f lowed the work until the water ran freely and every chance make an outlet was seized.

The spring tides and storms caused further delay, and wh at the end of March the machines finally did get to work, t first brood of larvæ was in the pools. It was a smaller bro than the Elizabeth marshes ever had at the corresponding s son, for more than half the territory was then already lar proof. Furthermore, a storm with heavy tide came in duri the early days of April and, while it delayed work again fo few days, it brought killies into almost every pool, and by t

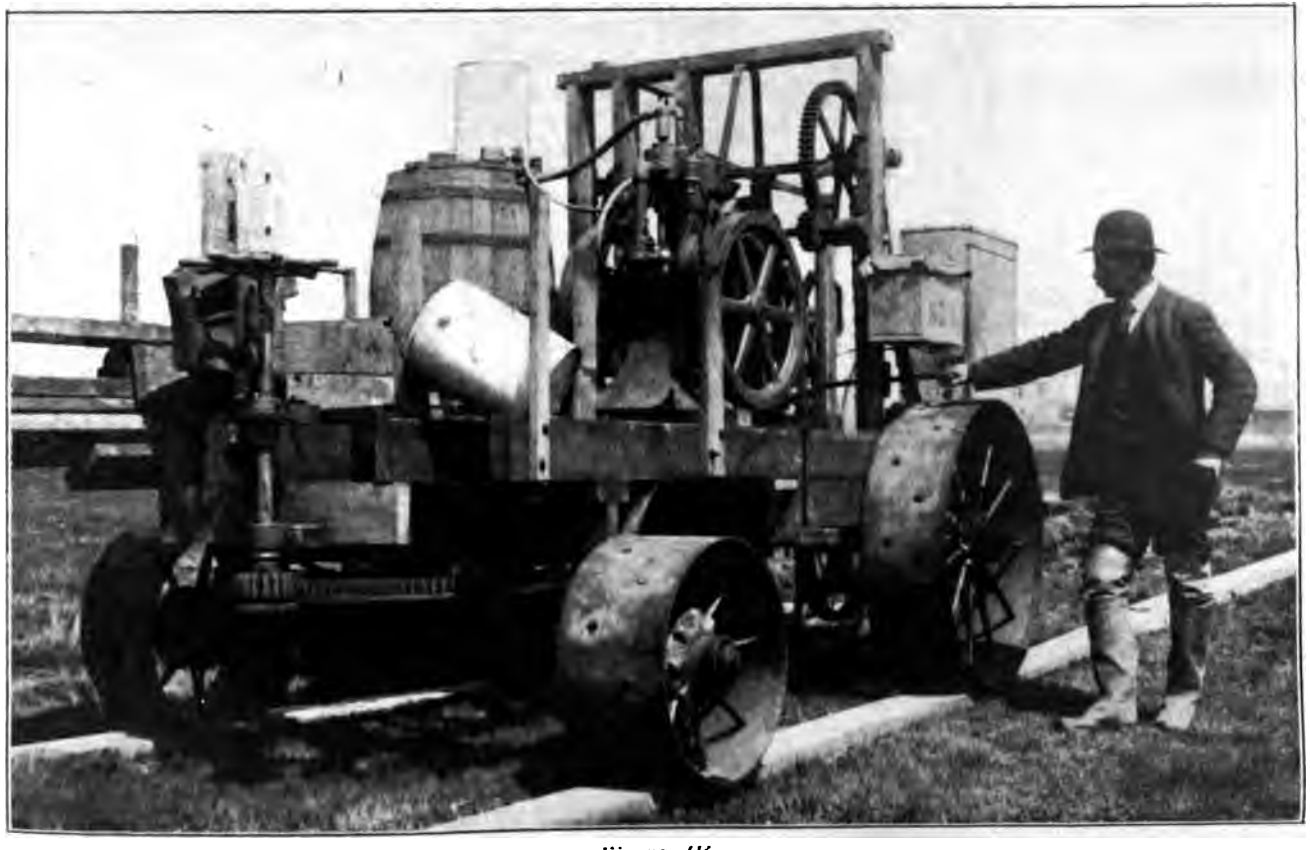

Figure IV.
The new model "True Ditcher" used by Contractor Jesse P. Manahan. There are five of these machines in service.

th, only a few wrigglers remained in holes where no fish had en able to make their way.

April 29th, the second installment of larvæ had hatched from e over-wintered eggs, and the pools were swarming again with ung wrigglers; but their breeding area was still further nar-wed and every day dried out some new places and left the rvæ to drown in the mud bottoms. May 22d, the first brood of lults was on the wing, all *cantator,* and in such scant numbers at a migration to any considerable distance so as to cause ouble was out of the question.

The third larval brood was in the pools during the early days f June, and this was mostly *sollicitans;* so there were still over-intered eggs that were hatching and not the results of this ear's adults. Quite a lot of the mosquitoes that were present n the meadow at that time undoubtedly came on from the Lin-en marshes just below, and some of them almost surely from taten Island, a small section of which, almost opposite Eliza-ethport was not properly drained at that time.

By the last days of June practically all the work was com-leted, and during the early days of July, practically within the ime limit of the contract, the entire work was completed and ertified for payment.

For variety, complications and obstructions, this meadow has ot its equal in the State. Originally, with plenty of natural utlets for all the water that came on it, the artificial interrup-ions, chiefly by the Central Railroad of New Jersey, had com-letely changed its character and made it a pest hole in which osquitoes bred out in uncountable millions. The original streams when blocked became stagnant dead ends, and the black rass, which makes excellent salt hay, was replaced by the use-ss reeds and other coarse, sedge-like vegetation. Besides, ex-ept during the winter, the marsh was almost impassable and it as positively dangerous for one not used to such territory to enture on it. East of the railroad line the problem was compar-tively simple; west of that barrier it taxed all our resources to et the water off without expensive canals or drains of large ize.

I had hoped to get the work just south of the Elizabe meadows well under way before midsummer, but as I failed this for reasons beyond my control, I feared that Elizabe might not get the full benefit of the work done. Fort nately matters turned out better than I had hoped, as appears l the report of Mr. Richards, the Health Officer, under date October 9th.

He writes: "The first noticeable appearance of the salt-mar mosquitoes in 1907 was on August 4th, and they were troubl some for about two weeks. Since that time there have be almost no salt-marsh mosquitoes noticed in any part of the ci except on the edge bordering the salt meadows, where they ha been in evidence in small numbers until now. The flight August was not a heavy one, and no great discomfort was exp rienced. They were mostly *sollicitans.*"

"During June and July, in the house-to-house canvass whi I had made this year, I had all cisterns noted, and on Augu 1st began to send out notices directing the owners to close and t them up. Up to this date 344 cisterns have been closed a filled in with earth, thus removing them permanently from t city. It has been necessary, in many instances, to extend t time until early spring on account of expediency, so that June 1st of next year we shall have removed a total of 400. Y will see that this will help some.

"The cisterns which remain in the city are chiefly those in ba kitchens or sheds within a covered building, and which will pro ably never be a menace so far as mosquito breeding is concerne

"We have had considerable opposition in this work, and o motives have been misunderstood in many instances, and amo others attributed to a desire to cause the installation of ci water controlled by a private company. In July we thought th by the use of kerosene oil we could make all cisterns safe, a with this in view a list was furnished the oil man, and with o of our inspectors he treated all cisterns. This made them s for awhile, but certainly stirred up a hornet's nest among t owners, and no second application was possible later on in season. Although no harm was done to the water for washi purposes, it served as an excuse later on when notices w

served for the owners to vent their spite upon the Board of Health.

"The catch basins were oiled, over 800 in number, on the following dates: June 24-29, July 8-13, 22-27, August 8-13, 29-31, and September 9-13, making six treatments to each basin. Besides this, whatever stagnant pools were found in the city were treated during the season. The total cost for oiling was: Labor, $195.75; oil, 46 barrels, $115.03, making a total of $310.78.

"Owing to the rather cool summer, the water in cisterns did not become warm until September, and no breeding of any account was observed in them until this date. During September mosquito larvæ were observed in almost every cistern examined. This applies to cement or brick cisterns, and not to wooden casks. In these latter, mosquito larvæ were observed from June on.

"I have seen less than a dozen mosquitoes inside of houses this summer, and I have had absolutely no complaints on account of this species, so you will see from the above that we have had a remarkable year from a standpoint of mosquito absence."

This communication really speaks for itself and needs little comment or explanation. The flight of marsh mosquitoes in August came in part from the Linden marshes, and, probably, in part from Staten Island. The majority of the specimens remained on the drained marsh, and were noticeable throughout the latter part of the season along the edges. The New Jersey portion of this source of supply has been pretty well eliminated, the Staten Island portion is partly improved and the complete drainage has been provided for.

The most interesting feature of the account is the effective house-to-house campaign to locate breeding places for *Culex pipiens* and the persistent and systematic treatment of catch basins and other local breeding places. As to the effectiveness of the work done there can be no question, and each year this kind of work will lessen in amount as breeding places are permanently removed. Even the catch basin supply will in time become much reduced as the numbers of specimens are gradually lessened. Elizabeth was the first of the cities to become actively interested

in mosquito work, and it is at present in perhaps the best condition of any.

The local Board of Health and its efficient Health Officer deserve the highest praise for the effective work done.

Jersey City.

During the winter of 1906-07, the governing body provided the sum of $2,500.00 for mosquito work within the limits of Jersey City, in the form of an appropriation to the Board of Health. This appropriation came in answer to a request made by the Board, and the request was based upon the survey and estimates prepared by the office. The committee of the Board to whom the matter was referred consulted with me, and in due time notices were prepared and served upon the owners of the marsh land—very much more numerous, by the bye, than we had anticipated.

Where the owner could not be reached copies were posted on the land, and early in March all were in default, so that the Board had jurisdiction to carry on the work. Specifications were prepared by me and maps supplied, and bids were duly advertised for. Mr. Jesse P. Manahan, of Monmouth Beach, proved to be the lowest of the three bidders and the contract was awarded to him for the sum of $2,100.00.

Snow, storm and tides were all adverse, and although the work was started during the early days of April, progress was extremely slow because the water laid so deeply on the marsh and everything was soft and without texture sufficient to hold a ditch or to support the machines which had been relied upon to do a large portion of the work. Eventually it proved necessary to do most of the trenching by hand, but by means of special saws and other tools excellent results were obtained.

By the end of April one-quarter of the work was fully completed, and Mr. Henry Smellie, Inspector of the Board of Health, with Mr. Wm. Delaney, one of the Commissioners, had kept close watch on what was done. During the first week of May half the work was completed, and large gangs of men made use

Figure V.

... the Health Officer; near the centre, Com-

of the better weather conditions. But these same conditions also favored the development of mosquito larvæ, and on May 6th, on some parts of the meadow, myriads of them appeared in the pools. Development proceeded so rapidly that holes were filled with sods, and ditches were run without regard to continuity of work, simply to get off the water from the worst places. On May 10th I made rather a careful survey of the work, and arranged that if any large proportion of insects reached the pupal stage oil was to be used on all pools not completely dry. By the middle of the month, however, the danger was over; some of the insects did reach the pupal stage, but in spite of frequent heavy showers the ditches carried off the water so fast that very few adults came to maturity.

May 23d I covered the meadow again in a general way, and found that the brood of larvæ had been completely wiped out. There were not mosquitoes enough on the entire meadow to be annoying, and not enough to get into even the immediately adjacent parts of the city. There were only little odds and ends of ditching and filling to be completed, and only a few men remained at work.

A series of storm tides during the last days of May retarded the finish somewhat, but gave an excellent chance to test the effectiveness of the work done. It was found that where the entire meadow was covered at high water, so that every depression was bank full, the following low water carried off everything within 25 feet of each side of each ditch, and at a distance of 50 feet left only a small remnant, which disappeared at the next period of ebb. The work, therefore, is sufficient to completely drain the entire marsh within 40 hours after it has been entirely covered by tidewater.

June 10th the work was entirely completed, and the contractor received a certificate to that effect. Messrs. Smellie and Delaney, for the Board of Health, verified all the work done and expressed their satisfaction.

While the bulk of the mosquitoes infesting Jersey City were undoubtedly salt-marsh migrants they were not by any means the only species in fault. This was realized by the Board, and, as they had an unexpended balance of $400.00, they invested in a

spraying outfit and a supply of fuel oil. Mr. Brehme accompanied Commissioner Delaney May 15th, and again June 18th on a tour through the city, locating danger points and places that seemed to require treatment.

Until midsummer Jersey City enjoyed a novel freedom from mosquito troubles. Windows were left open, unscreened screened porches were abandoned for the open piazza or stoop and the community hardly realized that summer conditions actually existed. Late in August, however, conditions became worse. The local supply of dirty-water species became abundant enough to be annoying, and increased steadily during early September. The unwonted freedom during the early summer made these later troubles much more annoying than would otherwise have been the case, and yet every one realized that the "swarms" of other years were absent.

During the early part of October I wrote Mr. Wm. Delaney, Chairman of the Committee on Mosquito Work of the Board of Health, and under date of the 21st of that month I received the following reply:

"Dear Sir—In reply to your communication of October 10th, in reference to the mosquito problem in Jersey City, I have the honor to inform you that the efforts put forth under your direction during the past summer, particularly the ditching of the meadows, have proven successful. All reports from that beautiful residential section of the city adjacent to the West Side Park, where the *Culex sollicitans* have been so annoying in former years, have been so favorable that I am sure the work is appreciated, and that for the first time in the memory of a resident of Jersey City the city has, during the past summer, been practically free from the annoyance of the latter species of mosquitoes.

"The *Culex pipiens,* however, have been quite troublesome since the latter part of August. Until then the circumscribed pools or breeding places in the city were treated with fuel oil, and the breeding of this species was successfully prohibited. But, owing to a severe illness, I was compelled to abandon the supervision of the work, and the result was that the pest got ahead of us, and on September 1st the work was suspended on account of

the appropriation for such work being exhausted. The work done, however, showed a marked improvement over former years, and I have secured an ample appropriation for next summer, and, with intelligent and persistent effort, I am sure the results will be most gratifying.

"I now want to call your attention to the meadows on the New York bay shore east of the Central railroad track and south of Jersey City, where we were led to believe no mosquitoes were bred. On June 4th Mr. Brehme and myself inspected that territory, and found that it was a very fertile breeding place. I immediately set men to work oiling, and successfully prohibited further breeding there. I have secured an appropriation from the Board of Finance for the ditching of these meadows, and the work will be started in the early spring.

"Your attention is also called to our neighboring city of Bayonne, where I believe the pest is bred to an alarming extent, and, as we are only across the street from Bayonne, it would seem miraculous if we did not get many mosquitoes from that section; also that part of the meadows lying south of the Penhorn creek, in the vicinity of Snake Hill, in the township of Secaucus."

As to the Bayonne conditions, these are in course of improvement, and will probably be eliminated as a source of danger early in 1908.

As to the Secaucus area, that development was a totally unexpected one. This meadow has been inspected every year since we began work, by both Mr. Brehme and Mr. Grossbeck, and, while it has been reported as looking dangerous, no larvæ had at any time been actually found there. In early September, however, reports came of a flight of specimens across Newark into South Orange and Montclair, and the only possible source of supply, with the winds as they were, was this Secaucus marsh. Mr. Grossbeck was, therefore, sent to investigate, and found in the mass of pupa shells left in the pools, as well as in the swarms of adults then on the meadow, abundant proof that our suspicions were correct. The heavy rains of early September and a series of flood tides had kept the shallow depressions full of water long

enough to hatch and bring to maturity every egg that was on the meadow, and it is now restocked with eggs.

This meadow probably does not mature a brood of mosquitoes more than once a year. There are no large pools, the surface is very level and only shallow depressions are found at any point. But there is no way for the water to get away except by evaporation and soaking into the ground, and while, under ordinary conditions the surface water from either rain or tides will disappear in three or four days; yet under such conditions as occurred this year it will remain long enough to bring a brood of mosquitoes to maturity.

It goes without saying that this is one of the areas that will receive attention early in 1908.

Newark.

Those early swarms of mosquitoes that in years gone by invaded the city of Newark in May and at intervals thereafter during the summer, have ceased to exist. So far as the salt marsh mosquitoes are concerned, Newark is almost free. Up to midsummer mosquitoes were scarcely in evidence, and the band concerts in the East Side Park, close to the salt marshes, were enjoyed by hundreds of people without annoyance. The only flight from salt marshes came in early September from the Secaucus meadow, as explained under the Jersey City heading.

Nevertheless, Newark is by no means mosquito-free. In a rapidly growing city where new streets are being laid out, building operations are going on, and all sorts of improvements are under way, there are always depressions or holes that retain water long enough, under favorable circumstances, to develop the rain barrel species—*Culex pipiens*. There are still numerous open lots where water remains for long periods, and these serve as constant sources of supply.

But in addition to this, Newark is a great manufacturing city, and there are hundreds of establishments, large and small where vats, tanks, cisterns and other receptacles hold water more or less continually. That mosquitoes breed in such places, I know,

Figure VI.
The bog saws and the men that use them.

Figure VIII.

Taking out sods *between the saw* cuts with shovel and hook.

use the wrigglers have been actually found in immense num-
in the supply tanks in one factory and those vats are not
rent from hundreds of others in the city. And in the sewer
ns there is yet a considerable source of supply; more abund-
in the outskirts than in the heart of the city; but present
e or less, everywhere. Too much praise cannot be given to
local board of health which has recognized its duty in the
ter and has done all that lay within its power to carry it out.
he following communication speaks for itself:

In reply to your favor of recent date, inviting me to send you
ief resumé of work done by the Newark Board of Health in
ampaign of mosquito extermination to date, I submit the fol-
ng, which you are at liberty to reproduce should you deem it
nterest.

The ditches which were cut under your supervision on that
of salt marsh meadow included within the boundary line of
city of Newark, covered an area of some 3,500 acres, worked
ectly the past summer, although some of the ditches are five
s old, and the latest of them cut four years ago. Our Newark
dow was kept perfectly dry the past summer, with but one ex-
ion—the Ebeling tract—which, as you are aware, has given
nore or less trouble because of the overflow of the Peddie
et sewer ditch. Mosquito-breeding on this section, however,
very light.

I have kept an inspector steadily employed on our meadow,
ecting the ditches and keeping them free and open. His re-
s show very little breeding, which we kept under control by
of oil.

While these ditches worked perfectly and there was no breed-
on our meadow, still there seemed to be little relief from the
quito pest in Newark up to and beginning with the summer
905. Upon investigation I discovered that the mosquitoes
ch had infested Newark, especially in the northern and wes-
sections, in great swarms, were not the salt marsh variety,
were fresh water mosquitoes. I at once started an inspection
he entire city and discovered that Newark was completely
ounded by mosquito breeding; on the one side by the salt
sh variety, and on the other sides by countless breeding places
ne fresh water variety.

Beginning with the season of 1906, with the assistance of our
ectors, I located many breeding pools—some very large—and
ceeded in getting rid of many of them either by draining into
ers, or filling them up. In several instances we had the city

scavenger fill them with garbage and ashes, while we also we[illegible] liberal with our oil, and when we came across a pool that [illegible] could not drain, or fill in, and that oil could not cover, owing [illegible] weeds, we resorted to crude carbolic acid, which must be us[illegible] with extreme care, but accomplished the purpose for which [illegible] used it, very satisfactorily. This work was kept up during th[illegible] summer of 1906, and we obtained considerable relief.

"Beginning with the season of 1907 we went to work earl[illegible] I recommended to the Board of Health that an extra inspector [illegible] allowed me, to devote his entire time to locating and doing awa[illegible] with breeding spots throughout the city. This was granted, an[illegible] I took the inspector who had been at work on the meadows, an[illegible] who was thoroughly familiar with mosquito breeding, for th[illegible] city work, and employed a new man for the meadow work.

"The result of this warfare on the fresh water mosquito bega[illegible] to show satisfactory results before the summer was far advance[illegible] The inspectors were given to understand that there would be n[illegible] excuse received for breeding in their respective districts. The[illegible] were told that when they discovered standing water in their dis[illegible] tricts they must either get rid of it, or keep it coated with oil.

"Newark, aside from an occasional spell the past summer whe[illegible] the mosquitoes were driven into our midst by heavy and steady [illegible] winds, has been quite free from the pests. We will never obtai[illegible] entire relief until Bloomfield, Belleville and Irvington, which are[illegible] our neighbors, take steps to exterminate the mosquito breeding [illegible] in their respective territories bordering our boundaries, as the[illegible] mosquitoes are blown into Newark when the wind is favorable.

"We have learned much in the art of mosquito extermination during the few years we have been engaged in this work, and have now reached a stage nigh on to perfection.

"Each inspector knows just where water will stand in pools in his district, and after every rain visits the pools and sprays them with oil. In the meantime, during dry spells, he directs his energies toward having the holes filled. They also inspect every receptacle they find on their respective districts that will hold water, and when they are found to contain water, over they go, bottom side up.

"Newark has parted company with mosquitoes, and with each succeeding year we will see less of them.

"We are now winding up our campaign for this season, but will start out with renewed vigor in the spring and keep at it with a determination to rid Newark of all mosquito breeding.

"I have had the co-operation of Secretary Alonzo Church, of the Essex County Park Commission, who has kept the sewer basins in the parks free of all mosquito breeding.

"The cost to the city for the mosquito campaign during the past summer was comparatively small, and consisted of the following:

Labor. Caring for meadow ditching,	$184.21
Salary Mosquito Inspector—caring for and oiling inland pools of stagnant water, etc.,	217.04
Oil,	36.16
	$437.41

Respectfully,
JOHN W. DOBBINS,
Chairman, Special Com. on Mosquito Work."

Newark Addition.

When the marsh area belonging to the City of Newark was drained in 1903 and 1904 there was a small area just south of Bound Creek, extending from the Elizabeth City line to the Pennsylvania Railroad, which was not included in the contract. This tract was, until about three years ago, within the Waverly town limits, and was not then considered as within the Newark work. The area was not a bad breeding section, and was not considered a source of such danger as to warrant an application for more funds. Subsequent inspections showed that, although our estimate of it as a danger point was on the whole correct, there was, nevertheless, a constant development of small broods, which were always noticeable on the meadow and provided eggs for other sections.

We found also that on this area there was a series of ditches put in about 40 years ago, by a company that undertook to reclaim the meadow, but failed before the work was completed. About 35,000 feet of ditches, it turned out later, were on this area. Another section is north of Bound Creek, between Maple and Bound Creeks, the Peddie Street sewer and the Pennsylvania Railroad, and on that we found some 30,000 feet of old ditching.

It became a matter of great interest and importance to determine the condition of these ditches, and to see what changes so great a lapse of time had produced in their effectiveness. They were found to be almost level full of a soft material that proved

to be mostly dead grass, and after a careful examination by Mr. Brehme, assisted by Mr. Wm. J. Erhard, who during the summer is employed by the Newark Board of Health, Mr. Erhard was employed for three months at a total expense of $250.00 to clean out these ditches with the view of restoring their effectiveness if possible.

The work began in March, and was continued as opportunity and weather permitted, until the entire line of old ditching had been gone over. For fully half their depth the ditches were simply clogged by the dead grass that had accumulated in them year by year, and when that had been removed, they performed their work as well as ever. The walls were still clean and firm, and there seems to be no reason why they should not last another forty years.

The extent of the work was so great that the ditches were not cleaned at once to their full depth, sufficient being done, however, to remove surface water, and an addition of 1500 feet of new ditch was put in to relieve a few danger points. The result is an excellent clean piece of marsh land from which no mosquitoes need be expected in the near future.

Mr. Erhard was re-appointed for the summer by the Newark Board of Health; but with added duties as City Inspector, an assistant in marsh work being provided. These two men have in the course of the season continued the work of deepening these old ditches and restoring them to their former condition of activity.

The importance of this experimental work lies in the fact that it proves to demonstration that a properly cut ditch in a peat marsh lasts almost indefinitely, and may be restored to activity after years of neglect. With a very little care annually such ditches never cease work and the permanence of the improvement now being made in the meadow conditions may be considered demonstrated beyond reasonable question.

Linden Township.

Inspections made during the season of 1906 proved that just south of the Elizabeth river in the limits of Linden township,

Figure IX. [illegible] from the direct

Figure X.

A sod-filled area on a salt marsh. This was a "rotten" area with numerous small, *very deep holes that did not drain* completely.

some exceedingly bad breeding places existed, from which the city of Elizabeth derived an abundant supply of mosquitoes at times when its own meadows ran short.

It was intended to take these meadows in hand very early in the season of 1907 in order to relieve Elizabeth from infestation that might lessen the apparent benefit derived from the work within its own limits. Formal notice was served upon the board of health of Linden township in February, 1907, and an apparent understanding established, so that it was believed that as soon as funds were available work might be begun; but delay after delay occurred, and for some reason the necessary action was not taken by the local authorities until June, long after the first brood had emerged from the meadow, and when the second brood was well under way. By the time the period limited in the notices had expired and bids had been called for, June was over, and the contract for drainage was not assigned until July 6th. Work was begun immediately and carried on as rapidly as circumstances permitted.

The Linden marsh area is one of those cut by railroad embankments, and in which the natural drainage has been interfered with; but not so seriously as in the case of the Elizabeth marsh, because more openings have been left for the escape of the water through the railroad dam. Along the bay shore there is a series of manufacturing establishments, one of them, that of the Grasselli Chemical Company, very extensive indeed, and the cinders and other refuse from these works have been used to fill around the works and along the bay shore. This also has interfered somewhat with the natural drainage by imposing a barrier along the shore which covered everything except the larger streams. The tendency, therefore, has been altogether to throw the water back on the meadow, and we found, in consequence, that the most serious breeding places and those that were most troublesome to deal with, were at the edge of the highland. Work was therefore begun at that point and the worst of the breeding places were disposed of in short order.

A large part of the marsh lying along Morse's creek is good solid meadow, which grows heavy crops of salt hay, and of this a large area is owned and cut by the Grasselli Company to obtain

material for packing. These meadows were already partially drained and little more was needed to put them into good shape.

Other sections lying southward to the Rahway river were much lower and more broken up, and there was considerable rotten meadow. Fortunately, the two or three large creeks that still have unrestricted outlets in the Kill and through the railroad embankments, proved sufficient to take our drainage ditches, and there was no delay on the contractor's part. The ditches along the edge of the highland were mostly cut by hand, while those on the broad meadow were cut mostly by machine; three machines being in service during most of the period.

Reference has been already made to the fact that there were some existing ditches on the marsh, and most of these were in such shape that it was necessary to clean and deepen in order to give proper outlet to the water. In view of the interruption of the direct drainage it was also necessary to put in a few large intercepting ditches, and these were made 20 inches wide, and some of them deeper than the regular ditches. The contract called for ditching as follows:

Existing ditches to be cleaned and put into proper shape,	14,272	feet
New ditches to be dug—		
20x36 inches,	400	"
20x30 inches,	1,980	"
10x30 inches,	248,160	"
Total new ditches,	250,540	"

A large part of the sods taken from the ditches were used in filling, especially along the rotten meadow bordering the Rahway river and toward the edge of the high land. The full amount of work required in the contract was completed, and payment was duly made after it had been carefully inspected and approved.

The completion of this meadow following the completion of the work on the Elizabeth marsh removed a source of danger to the city of Elizabeth, and also eliminated the most productive source of supply for the Orange Mountain settlements. Situated as this meadow is, between the Elizabeth and Rahway rivers, the insects that bred on it had a free range of flight along either

valley, and our experience has been that from this source a large part of the trouble in South Orange, Montclair, Summit, Short Hills and adjacent settlements arose. The report of the inspections made in those territories during the latter part of the season bears out this belief.

Rahway.

The city of Rahway is situated on the Rahway river, beginning about one mile west from its mouth. From the boundary of the city to its mouth there is marsh on both sides of the river, and for a short distance into the city there is an extension of salt marsh, which breeds mosquitoes in considerable quantity.

At about the same time that proceedings were begun for the drainage of the Linden marsh area, formal notice under the law, was also served upon the board of health of the city of Rahway. This body co-operated cordially, served the necessary notices, and in due course the municipal government made the small appropriation—two hundred dollars—that we believed to be necessary to drain that part of the salt marsh area lying within the city boundaries. Long before we succeeded in getting ready for the work on the Linden marsh, the money was available from the city of Rahway, and when the Linden contract was finally awarded, the contractor was instructed to extend his work along the Rahway river, so as to include the city work.

Fewer ditches than were counted upon were required; but the work of placing them was unusually difficult, because of the character of the territory, the impossibility of using the machines and the remoteness from the other work. It was also found that while less work than was estimated was actually required within the Rahway city limits, yet in order to make this work effective, more than would have been otherwise needed was required on the immediately adjacent parts of the Linden marsh. Practically the entire sum appropriated by the city was therefore needed to make effective the city work; but when completed a very good piece of drainage was accomplished, and all chance for mosquito breeding on the marsh area within the city was eliminated.

Rahway is in the direct line of flight for mosquitoes that breed on both sides of this river in both Linden and Woodbridge townships, and as soon as work was well under way in this region its influence was at once felt in the city. The health officer of the board assured me early in October, that during the latter part of the season there had been an altogether unusual freedom from the mosquito pest in the city, and that very few of the familiar salt marsh forms were in evidence. By the middle of September the work was completed, and shortly thereafter the contractor's bills were certified for payment.

Raritan Township Marshes.

From the mouth of the Raritan river and extending west and southwest along the windings of the river to within a few miles of the City of New Brunswick, a salt marsh extends, chiefly along the northern bank of the river, a small portion of which is in the Township of Woodbridge and a very considerable area in the Township of Raritan.

The Township of Raritan, although a very extensive one, is very thinly settled, the center of population, Metuchen, having been separated as an independent borough. The result is that the township is really very poor, although the borough within it is well-to-do. The borough of Metuchen suffers from the breeding places in Raritan township, and from that same breeding area the insects travel on an east and southeast wind to New Brunswick and along the river, sometimes even to Bound Brook and Somerville.

Surveys were made early in the season to supplement and correct the surveys made in previous years, and during the month of May the necessary formal notice was served upon the Board of Health, and a personal explanation of the character of the work intended was made at a meeting of the Board.

The ownership of this stretch of marsh area is very much divided, and there was so much uncertainty and difficulty in the matter of securing services that it was deemed best to advertise the notices in addition to posting them upon the marsh. So far as

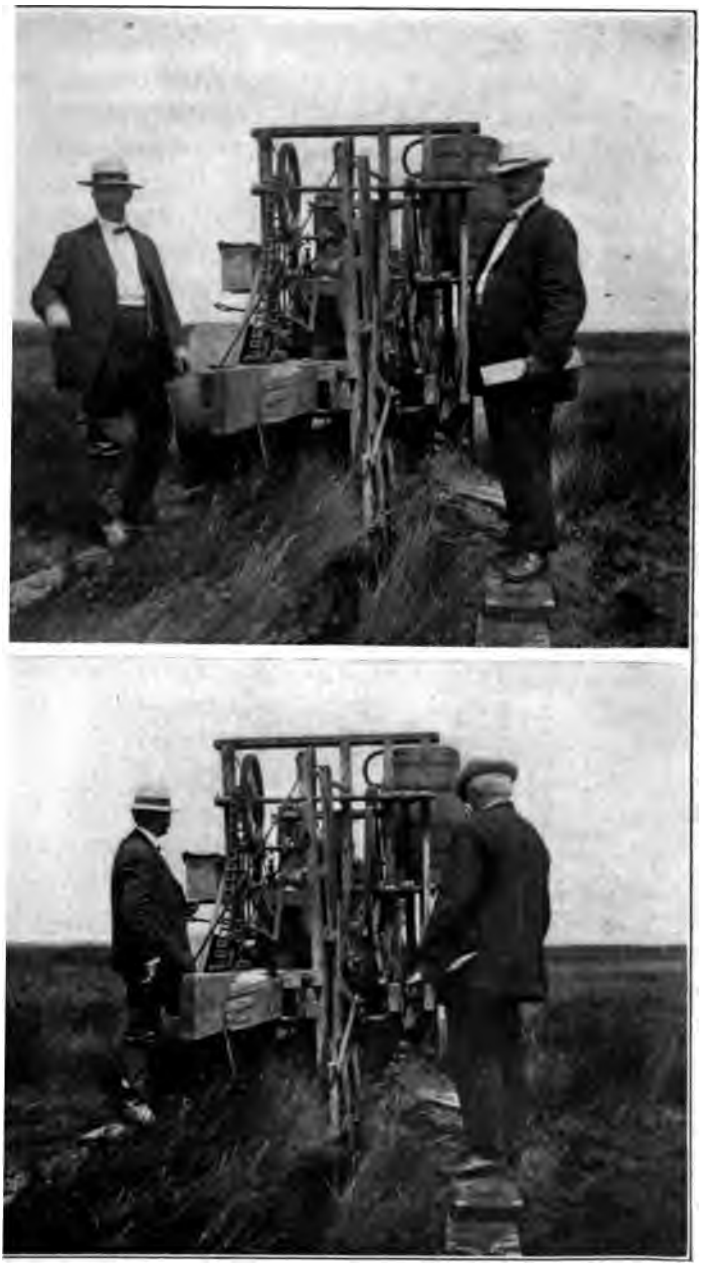

Figure XI.

B. Voorhees, Director, and Contractor J. P. Manahan, on the arshes inspecting the work.

the owners were ascertained they were very cordial in their co-operation, and after all the preliminaries had been completed, the contract was awarded on the 1st day of June for the sum of three thousand four hundred and seventy-five dollars ($3,475.00), the work to be completed by the 1st day of October. About 169,000 feet of ditching were required, and a total area of 1,456 acres was treated.

No railroads cross this marsh area in such a way as to interfere with the drainage. There are several lines of "clay roads" that extend from the highlands directly to the Raritan river; but these are all parallel with the line of drainage, and did not in the least interfere with our work. Some of the owners of the large areas co-operated by cutting their hay before the ditches were put in, and thus made it easier to locate the danger spots that needed special treatment. This proved of incidental advantage to these same owners afterward, because the grass took a new start and made a second crop possible after the work had been completed,—something unheard of in marsh agriculture.

The conditions along a portion of this territory are somewhat different from those ordinarily encountered on river banks. For quite a little stretch along the stream, the bank is from 1 to 3 feet higher than the marsh area beyond it, forming a natural dyke which, however, is not sufficiently continuous to shut off the entrance of water on the marsh area. It is sufficient to prevent the running off of the surface water, and in consequence the territory beginning some 150 to 200 feet back from the river degenerated into rotten meadow, and in some places even into quagmire. This made it desirable to put in an intercepting ditch parallel with the course of the river, of larger size than the usual drainage ditches, and to carry only every fourth ditch through to the river itself. Except for this complication the work was straightaway, and most of the outlets go into the Raritan river itself.

The change in the meadow texture as soon as the surface water was given a chance to run off was most remarkable, and was considered almost incredible by those of the owners and inhabitants of the township that were sufficiently interested in the work to visit it. This was eminently a meadow for machine work,

since the ditches were very long and generally parallel. The work was competed well within the required period, and inspections subsequently made showed that the drainage is perfect.

One rather unexpected danger developed late in the season. It appears that this marsh is a favorite resort for certain kinds of wild ducks on their migrations, and that some of the larger pools on the meadow are visited by them to such an extent as to attract gunners. Our drainage operations have eliminated these duck ponds, and intimations were made by some of those who had been in the habit of gunning over these meadows that when duck season came around, these ponds would be again found as full as ever, and that they would stay there. In other words, there seems to be some intention of filling or blocking the ditches that have been cut, for the purpose of restoring the marshes to their wet condition, so as to favor the duck hunters. The attention of some of the larger marsh owners and of the Raritan Board of Health has been called to this matter, and a patrol system has been suggested that would at least locate any blockages and favor their prompt removal. At the present time there is no way of getting at or punishing those that may interfere with the drainge system, except through the action of the Board of Health, which is both slow and indirect.

Sayreville.

The Board of Health and other officials in the Township of Sayreville acted promptly in compliance with the notices served upon them, and the contract for draining the marsh lands was awarded July 1st and work was immediately started. The problem here was simple and only 26,500 feet of ditching was called for by the specifications. July 12th the preliminary work was completed, and on the 15th inspections to test drainage were made and supplemental ditches to perfect the work were laid out. Thereafter the action of rain and tide on the meadow was observed, and by the end of the month the work was finally completed. Subsequent heavy rain and tides left no pools capable of mosquito breeding within twenty-four hours after the meadow was covered.

The Roosevelt Marsh.

The borough of Roosevelt was created during the winter of 1905-1906 out of a portion of the township of Woodbridge, which contained Carteret as its principal center of population. The borough extends along the south shore of the Rahway river and along the borders of Arthur Kill to the present township line of Woodbridge.

There is a considerable area of salt marsh at the junction of the Rahway river with the Arthur Kill, and it is really a continuation of the Linden marsh area. As a breeding place it left nothing to be desired, and the output of this territory traveled along the line of the Rahway river, first into that city, and then continued onward along the course of the river into the Orange mountains. It was, therefore, one of those areas that I was particularly anxious to get hold of early in the season, and notice under the law was served on the present Board of Health on March 9th.

There seemed to be some misunderstanding as to the objects of the work, and some fear that the new borough would be saddled with a considerable increase of expenditure before its financial affairs were adjusted, and the Board of Health and the Council temporized, requesting a delay until the counsel of the Board, then dangerously ill should have recovered so that he could be consulted in the matter. In consequence of the delays caused in this way it was not until mid-July that all the requirements of the law had been complied with and that bids could be asked for. Under the conditions, as they existed, the entire cost of the work fell on the State appropriation. The contract for the work was dated on the first day of August, 1907, and the date of completion was specified as October first. Work was begun immediately, and was finished within the time limit of the contract.

The problem in this township was very simple. There is only one line of single-track railroad over the marsh area, and that has been run over bridges at all points where water courses of any size crossed the line of way. Quite a number of creeks extend through the marsh between the Rahway river and the edge of the

highland, and the marsh along the Kill is very narrow, so t outlets for ditches were abundant and conveniently located. difficulties of any kind were encountered after the work v begun, and as soon as the matter was thoroughly understood the authorities every facility for carrying on the work v afforded.

The contract price for this territory was one thousand f hundred dollars ($1,400.00). The area ditched was 640 ac and the total number of feet of ditching was 93,000, of wh 3,300 were 20 by 36 inches. The remainder had the usual wi of 10 inches and depth of 30 inches.

Woodbridge Marshes.

The township of Woodbridge is unusually well provided w salt-marsh area. The township extends along the Arthur K between the borough of Roosevelt and the city of Perth Amb and for almost the entire distance there is a marsh area cut the broad railroad embankment at Port Reading. This railro however, does not in any way interfere with the drainage, a an unusual number of creeks cut into the marsh in such a way to make it easy to get outlets for ditches. The meadow itsel a horribly bad one, full of holes and rotten in every sense of word. It was almost impossible to get over some parts of it wi out hip boots, and an unusually large number of ditches was quired to make the drainage complete.

From the Arthur Kill the township stretches across to Raritan river, and on the north shore of that river marsh la extends from the Perth Amboy line to the Raritan towns boundary, not so much directly on the river as along the cou of the several creeks that empty into the river west of Flor Grove. The ditching scheme, therefore, does not drain direc into the Raritan except in a few instances, but into the cree which are deep, with good banks, and in all respects sufficient the purpose.

In addition to the marshes on the Kill and the Raritan ri there is another series along Woodbridge creek, extending fi

its head to its mouth, a distance of about five miles along its various curves and twists. This territory is really the most dangerous of all from the mosquito-breeding standpoint, and the output is in excellent situation for flights inland, Metuchen getting the first choice from this source.

Altogether the area of infested marsh land was calculated as 1,616 acres, and the amount of ditching required was put at 145,100 feet.

All sorts of delays occurred before it was possible to comply with all the requirements of the law, and not until August 24th was the contract awarded to Messrs. Skinner and Wolfe, for two thousand five hundred dollars ($2,500.00). There was delay from the beginning. The contractors claimed to be all ready to go to work as soon as they could get their ditching machine on the meadows, but day after day passed and no start was made, one excuse succeeding another. Hand work with especially designed ditching spades was finally started a few days before the expiration of the time limit on the contract, and when that time limit expired, October 15th, less than one-fourth of the work had been done. Acting on the advice of the Attorney-General's office, and after ascertaining that the contract approved and filed in the Comptroller's office would hold the appropriation, I waived the time limit and allowed the contractors to go ahead, which they did, making good progress with their hand spades and doing clean work. Half the ditching, including all that along the Arthur Kill, was completed by the end of the fiscal year, and certificates were presented for payment. After that the work proceeded intermittently because of interruptions by high tides and storms, and was not completed at date of presenting this report.

The ditches are good, well made, and do their work. Those first put in are not so deep as is called for in the contract, but they are sufficient for their purpose, and those put in later are in all respects up to requirements. The ditching spades are excellent for their purpose, and the method of using them secures a straight ditch that comes as near perfection as can be reasonably demanded.

The work done in this township is of great importance to Rahway, Metuchen and New Brunswick, as well as to the settle-

ments within the township. To a less extent Perth and Sou Amboy are affected, and the resorts known as Florida Beach a Boynton Beach. The borough of Roosevelt has recently be separated from the township, and, as the financial affairs were s unsettled when this work was undertaken, the Director, on a recommendation, set aside the total sum of two thousand fi hundred dollars ($2,500.00) required to do the work out of t State appropriation.

Long Branch.

When the work on the Shrewsbury River was taken in ha by the local authorities in 1902 and 1903 there were left some fe stretches beyond the jurisdiction of the communities that paid f the work. These were taken in hand in the following years, un all that remained was a small area within the City limits of Lo Branch, on both sides of a small water course known as Trot man's Creek, which empties into Pleasure Bay, in a marsh ar that was also more or less a breeding place.

After some correspondence with the local authorities I we over the city with some of the members of the Board of Heal after making a personal inspection of the marsh area, and pointed out such other places within the city as might be co sidered troublesome.

Formal notice under the law was afterward served upon th Board of Health which took such action as resulted in the appr priation by the municipality of a sufficient sum to do the wo required.

The contract was awarded to Mr. Jesse P. Manahan f $180.00 and the work was completed early in October and cer fied for payment. It is unfortunate that it was not possible get the wheels in motion early enough to prevent trouble duri the summer; but it is believed that, so far as marsh mosquit are concerned, Long Branch will suffer little in 1908, and t work also cleans up the last bit of salt marsh breeding territ on the Shrewsbury River.

Township of Middletown.

In this township, extending along the shores of Sandy Hook Bay, there are three areas of salt marsh between Keansburgh and Atlantic Highlands. The first and smallest of these contains about thirteen acres, and lies on both sides of a small creek that forms the boundary between the borough of Atlantic Highlands and the Township. The second of these is a much larger area extending from Leonards to Port Monmouth, on both sides of Ware and Compton's Creeks and their branches. The third area is along the course of Pews Creek and its branches, between Port Monmouth and Keansburgh, and is intermediate in area between the others

In 1906 the borough of Altantic Highlands, taking advantage of the law then in force, secured aid to the extent of three hundred and seventy-five dollars ($375.00) in constructing a bulkhead at the mouth of Many-mind Creek, and draining the marsh lands along that Creek, so as to eliminate the mosquito breeding places. This proved quite effective in reducing the trouble, but not to the extent hoped for, because of the near-by sources of supply on Sandy Hook and the adjacent township areas. That small area at its western boundary was especially troublesome, and application was made by some of the residents asking for a survey and, if possible, relief.

Accordingly, Mr. Brehme was sent to investigate, to prepare a drainage scheme, and to ascertain general conditions. Afterward I made two personal visits to the territory and recommended that two hundred dollars ($200.00) be set aside to drain the smallest of the 3 areas: it was all the money that could be paid out of the 1907 appropriation, and all that could be satisfactorily done this year.

The necessary notices were served, and in due time the contract was awarded and completed just before the close of the fiscal year; some 2,700 feet of ditching being required. The cost is altogether out of proportion to the amount of work required; and the major part of it is due to transportation and other expenses in getting to the ground and the time required to do the work.

The requisite notices for the larger areas were also served a the Board of Health has acquired jurisdiction to take immedi further action whenever additional funds are available. T largest of the areas is at present in hand for radical improvem in all save a small section at its western portion. When this wo is completed it will eliminate a large portion of the mosqu breeding area and until the work in progress has been carried enough to make it possible to judge of its effect, it is not co sidered wise to appropriate further sums for drainage on t area. On the other hand, it is also fair that where, at large dividual expense, considerable areas of marsh are rendered fit settlement, immediately adjacent breeding areas that lessen t value of the improvements made, should be eliminated. The co pletion of the drainage of mosquito breeding marsh areas in M dletown township is therefore one of the matters in contemp tion for early in 1908.

Sandy Hook.

That stretch or strip of land, known as Sandy Hook, formi part of the easterly boundary of Raritan bay and the natur entrance to New York bay, is now under the jurisdiction of t United States Government and, of course, beyond the scope the State work. Mosquitoes are known to be troublesome Sandy Hook, and in past years I have had the territory su veyed and reports sent to the commanding officer, pointing o the danger spots.

In 1906 the borough of Atlantic Highlands availed itself the law then in force, and drained and otherwise improved t marsh area within its limits, and also the outlet to Many-mi creek. Local interest in 1907 resulted in a movement to clean other marsh areas in the vicinity, as detailed under the head for Middletown township, and as Sandy Hook was well with the range of mosquito flights on a southeast wind. I ag opened communication with Colonel (now General) Charles Smith, the Commandant, who courteously supplied a pass t enabled Mr. Brehme to make the necessary investigation.

The following copy of his report speaks for itself:

"Sir—I herewith present my report on the conditions found on Sandy Hook. A very bad breeding place was found along the railroad, about one-half mile north from the first guard house, coming in from Highland Beach, and larvæ are in the pools at the present time. Wind from the south will carry the mosquitoes bred on this meadow directly to the Proving Grounds, and a southeast wind will take them into Atlantic Highlands. This meadow is about one thousand feet in length and varies from 50 to 150 feet in width; the worst place is the railroad ditch, which has no outlet.

The meadow just north of the Government dyke is also a bad breeding section, and filling and ditching will have to be done here. South winds will bring these mosquitoes to the Proving Grounds, and southeast winds supply Atlantic Highlands.

Things are very bad along the railroad for a stretch of about three miles. Improvements have been made along this railroad, and the sand and dirt to make these improvements have been taken out along the sides of the embankment making holes which were filled with water to-day, and contained larvæ. Then there are some blind ditches, some with fish and more without; those without fish had larvæ, while the ones with fish were free of larvæ.

The only thing that can be done with these places is to fill them. I don't think that many of these mosquitoes get into Atlantic Highlands, but they follow the railroad to the Proving Grounds; dense woods are on each side of the railroad.

A road has been built from Highland Beach to the Proving Grounds, and for the biggest part of this road sand and dirt was used for an under layer. This material was taken from the side of the road, many holes were made and these are now ideal breeding places. Larvæ were in most of them to-day and these holes will have to be filled to make them safe.

Conditions have been wonderfully improved on and in the vicinity of the Proving Grounds, and especially near the hospital, which was the worst place near the Proving Grounds. The old waterway has been entirely filled in, and a straight 6 feet wide and 1 foot deep ditch was cut, and all the low places and holes filled in the best manner, and it is impossible for any more breed-

ing to take place there under the present conditions. The rest of the bad places on the Proving Grounds have also been filled and a good job was done. The trouble that remains is on the places mentioned in the first part of this report, and which are all south of the hospital to the guard house near Highland Beach. I walked up one way and down the other so I could see all conditions, and which were found as reported."

Practically this means that the breeding places to which attention was called in previous years have been eliminated; but that new ones have been created by works in which the drainage question was altogether ignored. The engineer is in some respects the greatest enemy to the mosquito crusade, though he might be and should be its greatest friend and most effective assistant.

A copy of this report which bears date of October 14th, 1907, was forwarded to the officer in command, with the request that such action as was necessary, be taken to bring the matter before the proper authorities.

It is a pleasure to be able to add that the subject received very prompt consideration, and there is every reason to believe that the elimination of these breeding places will be undertaken in the very near future.

Long Beach Township.

Among the first of the seashore resorts to manifest an interest in the mosquito work was the borough of Beach Haven, situated in Long Beach township, and in 1903 a considerable sum of money was expended in ditching work under the supervision of Messrs. Wagner and Mellor, then in the employ of the office. A description of this work appears in my report of 1904, with a sketch of the work done and a statement of the further requirements of the region.

The results of the work were very marked. Within the limits of the ditched area salt marsh mosquito breeding was almost entirely abolished, but a considerable number of breeding places for *Culex pipiens*, the common house mosquito, still remained. Through the efforts of the local Board of Health these danger

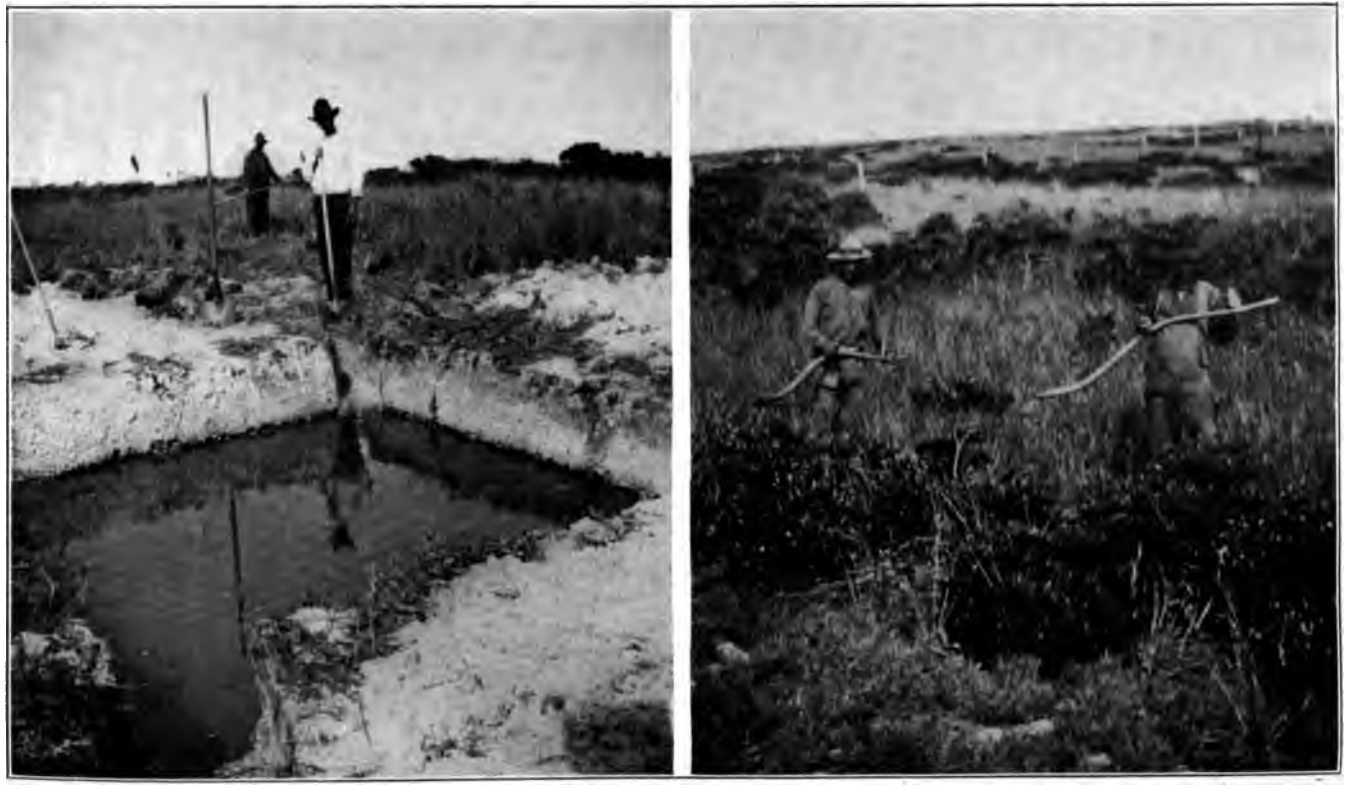

Figure XII

To the right, cutting brush to fill depressions; to the left, draining a depression among the sand hills to a permanent pool stocked with fish.

Figure XIV.

To the left, carrying brush for filling; to the right, filling a small depressed breeding area with sand.

points have been gradually eliminated, and the borough is now in very good condition. But to the south there is a long stretch of sand hills and marsh, extending seven miles to the new inlet, and in this territory there were numerous exceedingly bad breeding places. Every south or southwest wind was likely to bring in swarms from these areas, and the borough did not get that measure of exemption which it seemed to deserve. To the north, extending almost fourteen miles to Barnegat City, matters were even worse; but as north winds on which mosquitoes fly are the exception, this was a minor source of trouble, only a few coming in on quiet sultry nights. The main shore to the west is a hot-bed for mosquito breeding, and a persistent west wind, lasting two or three days, may bring a flight across Little Egg Harbor bay. The problem is not simple, therefore, and when at the request of the authorities I undertook work in Long Beach township I realized that it was quite possible that there would be little or no apparent effect during the present season.

During the latter part of March I sent Mr. Brehme to Beach Haven to look over the ground to determine the condition of the ditches that were cut in 1903, and to plan out a ditching and general grading scheme that would be practical at a cost within the estimates already made.

His report, under date of March 22d, was extremely encouraging and satisfactory. As to the condition of the work done he said: "The ditches cut four years ago at Beach Haven were found the same depth as when they were cut. The sand is so compacted that a ditch can be cut anywhere on this meadow; it does not ooze up as was first expected. The ditches that were cut six inches in depth are six inches to-day; those that were cut twelve and fifteen inches have still the same depth. The ditches have not been looked after since they were cut, and there is not one on the meadow that has any vegetation growing up from the bottom. The only fault is that the hay cutters cut only to within one foot of the ditch, and the old grass finally lays over and hangs into the ditch. This could be prevented by burning the old grass in spring at little expense, and with an occasional going over in summer to keep the bay grass out of the mouths, the ditches would be in good working order. Even the shallow ditches that

were cut drain so well that wherever they were put in the meac was dry. To find such conditions right after a heavy rain a snow such as we had on the 19th inst. is astonishing. While drained portion of the meadow was found to be dry, the u drained section was found full of water. The grass on undrained meadow was found to be ten inches in length; tl on the drained portion measured twenty-eight inches."

Maps were prepared covering the entire area between Barne Junction and the New Inlet, and were served, with the usu notice, upon the Long Beach Board of Health, which took app priate action early in June. In due course specifications w prepared and bids were invited, not only from the contract who had competed for previous work, but from local contracto and on June 14th I invited the contractors to go over the grou with me. Local labor conditions were such that no bids w made, but the territory was carefully examined by Mr. Jesse Manahan, who was the successful bidder, in company with M Brehme and myself.

At this time Beach Haven was practically free from mosquit within the borough limits, and no active breeding places w found. To the south mosquitoes increased in abundance a became a veritable nuisance at Holgates, a mile away. It dev oped also that there were many more places that held wa among the sand hills than were suspected, and that some of th depressions were so extensive that filling was out of the questic It was determined that such places should be drained to the lc point, and the water gathered into a permanent pool that could stocked with fish.

Work was begun July 10th among the sand hills, and, as progressed, plans were somewhat modified and methods of wo changed. Wherever it was possible water was given exit to tl bay. When filling was done a base was prepared with grass a branches of sweet bay and beach plum, to make a bed upon whi sand was piled to cover. This gives an excellent absorbing su face to the rain that falls, and prevents the sand from blowin in fact, it will prove a sand catcher when the sand storms occu and will aid in getting a more uniform level.

It was also found that the water level in these depressed areas was not much more than a foot beneath the surface, and that there was a variation in level of from three to four inches, due to tidal influence. Such ponds or pools as were dug, therefore, were made between two and three feet deep, and in the center of each pool a large barrel was sunk so that permanent water was secured. Into these pools "killies" were introduced, and they lived and flourished there to the end of the season. Throughout the summer these fillings and drainings worked perfectly. The heaviest rain-fall up to the end of September was fully absorbed in the fills as fast as it came down, and the pools did their work equally well, taking all the water from the ditches and sinking down to ground-water level within a day after the rains ceased. A period of dry weather favored the continuance of the work, and, during the entire month of July, neither Mr. Brehme nor myself found a single larva on the territory in course of improvement. But while there was little rain on Long Beach there were heavy showers on the mainland, and while the full-moon tides made no impression on the dry marshes of Long Beach the marshes on the Mullica river and along the shores of Great Bay were water-logged by them. During the last days of July reports came of immense broods of mosquitoes on the main shore, while in Beach Haven there were none. At my request Mr. Brehme attempted to make a collection of specimens for me, and by hard work among the grass in the evening on July 25th he secured less than a dozen old, worn examples. Practically there were no mosquitoes on Long Beach south of Beach Haven, and there were no larvæ in any of the territory on which work was going on. July 27th and 28th a west wind began to blow steadily, and I sent Mr. Brehme down to make observations August 1st, following myself on the 2d. All day August 1st the west wind continued, but no mosquitoes were noted during the day. A few began to appear in the evening, and on the morning of the 2d they were present in countless swarms in the grass along the bay shore, and much more abundant to the south than to the north. On the evening of the 2d, when I came down, the invasion was on in full force, and the hotel porches were uncomfortable, to say the least. Even on the beach itself there was

little relief, because the wind was still west. All night of the the same wind held, and on the morning of the 3d I found m ters about as bad as they could well be. On that day I went w Mr. Brehme over a large part of the territory where work l been done, and found not a trace of recent breeding. All specimens now present were very fresh and clean examples recent emergence. In the evening the wind became variable a shifted to the east, bringing first fog and then rain. On the hc porches it was sultry, and everybody was fighting mosquitc which furnished the almost exclusive topic of conversation.

On the 4th covered the area from Beach Haven north to L Saving Station No. 21, and while the rain of the previous ni had left plenty of pools there were absolutely no larvæ, and th was no sign of recent breeding. It was certain that the invas at Beach Haven and to the south had not come from this ar where no work had been done and where there were now bre ing pools in abundance.

On the 5th Mr. Brehme went to the edge of the marsh on t mainland east of Barnegat, and there he found great numbers pools filled with pupæ and pupal shells from which adults h emerged, and this was the condition throughout the mar Males and females were found here in abundance, while on c two days' tramp on Long Beach not a male was found. On t evening of the 4th I did find a few dancing males at the edge the town, but few out of all proportion to the multitude females.

That these mosquitoes that came in swarms to Long Beach August 1st, 2d and 3d came from the mainland and were r hatched on Long Beach is absolutely beyond question, and de onstrates the utter futility of local work only at any point in li with a flight from a bad breeding area. It proves that in 190 underestimated the travelling powers of the insects and the da ger from the west winds. I am informed, however, that w winds of so long duration are very unusual, and it was the coin dence of a heavy brood on the mainland just emerging, and continuous west wind to guide the migrating swarms, that det mined this enormous influx on Long Beach. As a consequen of this combination the supply that normally overruns the pi

belt was very materially cut, and Mr. Brakeley informs me that *sollicitans* was much less abundant than usual at Lahaway, and that there was no early August swarm. The flight was to the east instead of to the north, as in a normal season.

The rain of the 3d and 4th broke the droughty spell very effectually, and for several days there were more or less and sometimes very heavy showers. On August 8th and 9th Mr. Brehme was on the ground again, and now the pools that we had found so plentiful north of Beach Haven on the 4th were swarming with wrigglers well advanced in growth. The entire area to the south, so far as our operations had extended, was absolutely free from mosquito-breeding pools. Breeding was going on in some sections of the undrained meadow below Holgates, but among the sand hills not a pool was found and the system worked perfectly.

From this period on to the end of the month there was rain enough to keep the pools to the north in good breeding shape, and there was no chance for determining whether any additional flights came from the mainland.

August 21st there was another excessively heavy rain, and on the 22d Mr. Brehme again went over the area of work done to test results. Not a drop of water was found remaining in any of the fills; the center pools were all working, and the fish were actively running up the ditches so far as they were filled. The long ditch extending at the bottom of the depressed meadows was doing its work excellently well, and nowhere was there any accumulation sufficient to breed any number of mosquitoes.

By the end of the month the work was completed according to contract, and on September 10th I went over the entire ground with Mr. Brehme. At Sea Haven is Life-Saving Station No. 23, and between its station and the beach there is a long stretch of low marsh extending back to the lighthouse and beyond. This marsh had been ditched, and although it had rained heavily during the night, and indeed was raining while we were on the ground, the water was running out about as fast as it came down. This area is unsatisfactory because it is very little above mean high water in the bay, and there is a chance of ditches clogging by the washing in of eel grass and other sea weed. The St. Albans

Realty Company, the owners of this tract, have been advis conditions, and it has been suggested to them that wher dredging fills that were in contemplation were made, this should certainly be filled; especially at its head. About a south of Beach Haven begins a series of extensive glades ar the sand hills, and this reaches to the bay side about three-qua of a mile below Holgates. These glades or depressions irregular in form and size, but are mostly connected, and is a distinct low point that is marked by pools and shallow p until a short creek is reached that empties into the bay. A the bottom of this trough a ditch two feet or more in width varying in depth was cut until the creek was reached, altog nearly three-quarters of a mile, and this is really an arti creek, following natural contour lines. Into this creek ditches laid out through the low points of the connecting gl until there is a series of lines through every low point, an the water that falls on the ground is given a natural outlet. shallow pools were all drained in spite of the heavy rains, turtles and other animals were moving about in the soft mu taking refuge in the ditches. The larger, deeper ponds sh form now an enlargement of the creek. They rise and fall the tide, and are abundantly stocked with fish and other Already the drainage was assuming a natural appearance, with a little looking after next spring to make the lines of creek conform more perfectly to natural contours, the sy will last for years unless interfered with.

Altogether the work done here in Long Beach Township been interesting and instructive. It has demonstrated the p bility of completely eliminating mosquito breeding places in t tory of this kind at a reasonable cost, and it has shown that in poor communities work can be done with material abund at hand to improve the physical condition of that large are shore territory of which Long Beach is typical. The entire negat Bay district is affected by the results obtained in this v for it has shown very clearly how future operations may be and most effectively carried on.

Late in October Mr. Brehme made another trip to B Haven and makes the following record:

"An occurrence at Peahala on October 23d, the day before I got there, is well worth noting. On and for about a week before that date Peahala was practically free of mosquitoes. About one o'clock the wind from the south died out, and there was no wind for two hours. At three o'clock a very light wind set in from the west, and at four o'clock Peahala was swamped with *sollicitans* so bad that the men could do nothing but fight mosquitoes. Messrs. White and West, and several of the residents were at the edge of the meadow at the time, and they noticed the swarms of mosquitoes come across the bay."

"When I got down Thursday, the 24th, I found thousands of fresh bred *sollicitans,* and by the looks of things a very large brood emerged on the mainland meadow. I could find no trace of breeding on Long Beach, almost every hole is dry.

"I also made an inspection south of Beach Haven. The fish in the drainage pools are still alive, and no larvæ or traces of breeding could be found anywhere. But mosquitoes were there, fresh and in plenty, which doubtless came from the same places as the lot further north."

The Orange Mountain Area.

It has been my claim and my belief that when the salt marsh areas at the mouth of the Elizabeth and Rahway rivers were drained, a large part of the Orange Mountain mosquito problem would disappear. There was an opportunity to test my belief this season, both as to the source of the specimens and the effect of the drainage.

During the latter part of April all the members of the staff, Mr. Brehme, Mr. Grossbeck and myself, went over the territory between South Orange and Millburn to verify local conditions, to make some experiments with "Killarvæ," and to advise with Mr. William W. Renwick as to methods of dealing with local breeding places.

Up to the middle of May nothing was seen of any marsh mosquitoes anywhere. On May 18th Mr. Brehme reported a heavy brood maturing on the Linden marshes. At this time there were no mosquitoes on the Newark meadows, the broods on the Eliza-

beth marshes were almost under control, and only the Lind marsh at this point was untouched.

May 20th Mr. Brehme was on the South Orange Reservati collecting larvæ,and his report mentions the capture of a sing female *cantator.*

May 24th, Mr. Grossbeck was detailed to work out the exte of the distribution of this brood, assuming they had follow their usual course. His report is as follows: "This was a cle bright day; not one on which it would be expected that mc quitoes would be found in the dusty roads; nevertheless I h hardly stepped from the train at South Orange when I caught n first *cantator* on South Orange Avenue. I did not meet with a others until well on top the first ridge of the Orange Mountai and then several could be seen around me at any time. Here broke into the wood and stirred up hundreds in the low shru bery, many of which were swept into the net and determined be all *cantator,* males and females mingled together. In t valley between the first and second ridges of the mountains again broke into the woods and found things so near like wh was found on top the ridge that I cannot say in which places mc quitoes were worst. On the top of the second ridge they were r nearly so bad as on the first and in the valley, though abund enough; and this remained the same for a mile or so toward M burn, when they began to diminish in numbers. As I nea Millburn they became scarce, and it would take considera sweeping to get fifty. From Millburn I went to Short Hills the vicinity of the pools where *C. abfitchii* were found in numb as larvæ about two weeks previous. Surprisingly enough I not see more than twenty adult *abfitchii* and did see almost many *cantator.* Sweeping did not bring more to light: they w simply not about. Larvæ of *canadensis* were still in the poc but the main brood had emerged and these were only straggle On the Orange Mountains I collected a few *canadensis* larvæ a pupæ as well as a small brood of *sylvestris,* among which seve pupæ had already formed. A police officer who patrols the res vation told me that mosquitoes had made their appearance o about four days ago when, for the first time this year, he had leave the porch and go indoors. In spite of the large brood

canadensis that had emerged both on the Orange Mountains and at Short Hills, I only saw one adult of this species, which alighted on me but did not attempt to bite. In the evening I went to Passaic. The proprietor of the Shady Side Hotel told me that for the past four or five nights it was impossible to stay outdoors and that below the electric lights in the bar-room numbers were swept away daily. At the "Pagoda," which like the Shady Side Hotel, is situated directly on the brink of the Passaic River, I learned the same thing: that mosquitoes had made their appearance four or five days ago and were a nuisance since. By half-past seven I was seated on the porch of this latter hotel with an electric light over my head, and remained there until nine o'clock. Up to that time I caught one mosquito and was bitten by another. The one I took was *cantator*. Why I did not get more specimens after what has been said is undoubtedly because it was a very damp and chilly night, and not one that would draw mosquitoes.

May 25th. This day was much colder than yesterday and a brisk breeze was blowing that kept up all day. I began sweeping on the Garret Mountain at Paterson and in the first mile took one mosquito—*cantator*. I kept along the ridge to Montclair, and when near that place took two more mosquitoes in sweeping, which were also *cantator*. It appears therefore that the brood went in two directions: one along the Passaic River and another over Elizabeth and Newark into the Orange Mountains.

Mr. Dickerson reported *cantator*, males and females, at Nutley on May 19th. Females were also seen on the screens at the same place and time."

During the early part of June some of the residents of Passaic became interested in the mosquito question and located, as they supposed, the source of supply, just outside the city limits, in a low, swampy area, said to be always filled with mosquitoes.

Mr. Grossbeck was detailed on this service, and on June 20th covered the city conditions very thoroughly. His conclusion was that Passaic is a very clean city from the mosquito standpoint, and that very few develop within its limits. He located the areas complained of and found the mosquitoes; all worn specimens of *cantator* still active and ready to bite; the remnants of the brood that had come into the city about a month before.

The low moist area, overgrown with vegetation, forms an hiding place for the insects and there they lurked during th and from it sallied out at night after food.

July 19th, Mr. Grossbeck was again in the mountain, and ing the entire day found not a single marsh mosquito. H Mr. Renwick near Millburn, and learned that very few *ca* had been seen during the season and no *sollicitans* at all. locals were in abundance in their usual haunts; but imp ments were under way in the wooded areas against the well.

The rapid extension of the marsh work which practicall the Linden marshes out of service early in August as so of supply, made it seem useless to keep this territory under tinuous observation; but about the 20th of August report gan to appear of an invasion of mosquitoes at Paterson. not get copies of the papers containing the reports until some later, and on the 29th and 30th Mr. Grossbeck was again over the territory with instructions to spend the night in P son, his old home, and report results.

He started in at South Orange and covered the usual c to Millburn and Short Hills. Not a marsh mosquito of any was found in the entire stretch and only a few examples of species, which were collected and made no attempt to bite

Paterson was reached late in the afternoon, and Mr. C beck's report proceeds as follow: "I spent the evening at P son, stationing myself at the Passaic river on the east side c city. The night was cool, but there was no wind stirring a an hour and a half's stay I neither felt or heard any mosqu On the morning of the next day I swept the grass along the at this same point but saw no mosquitoes at all.

"The stories told by the people of Paterson of the recer vasion of mosquitoes are almost incredible; but are told sc formly by the residents of different and remote sections o city that they must be believed. The north and northwe portions of the city are the only ones that seem to have es the invasion and these are the higher parts of Paterson. A point I was told that twenty-four mosquitoes were killed i morning in one room. From another person I heard that

was impossible for the first night and that one member of the family bathed himself with kerosene and painted the screens and shutters with it, and that she herself was so severely bitten on the eye-lid as to be scarcely able to see in the morning. My sister, in the western section of the city, also was unable to sleep the first night, and had killed many of the adults in the morning, about eighteen of which she kept for me. All were very large and fresh, blood-filled *pipiens*.

All the indications are that no invasion of salt marsh mosquitoes struck the town; but that after a dry spell, followed by rains that formed pools simultaneously all over the city in which adults were induced to oviposit at once, a heavy brood of mosquitoes developed which reached maturity almost at one time. No attempt was made to investigate the matter further and to ascertain just where the mosquitoes bred."

That Mr. Grossbeck's conclusions are justified is indicated by two points: *First*, the eagerness to get indoors, which is a characteristic of the house mosquito and not of the marsh species. *Second*, the brief duration of the infliction. As soon as *pipiens* had fed it was ready to oviposit and disappear. Marsh mosquitoes would have hung about for a month, and could have been collected on the occasion of Mr. Grossbeck's visit.

There was no further trouble until September, and then a flight of marsh mosquitoes did strike across Newark and the Oranges and into Montclair—altogether the worst invasion of the season. It lasted only a few days, was utterly unlooked for and disclosed an unsuspected breeding area in Secaucus. While it is matter for regret that this late flight should have formed a bad close to an otherwise clean record, it is also matter for congratulation that it came so late in the season as to be very brief and revealed a breeding territory which we can clean out early next spring before another brood has a chance to develop.

From all the Oranges and from Montclair the record is uniform and is expressed in the following letter from Mr. Spencer Miller, of South Orange: "My dear Dr. Smith—We were freer from mosquitoes in South Orange this year than ever before. We saw almost no marsh mosquitoes until September—I think

about the 15th. It might have been the 19th. I congratulate you on the salt marsh work and our own B. of H. for the way in which the locals were kept down. We drained one bad swamp under the Duffield law this summer, and the owner *paid in full*."

And this brings me to the point that throughout this territory included in the first and second ridges of the Orange Mountains, the residents are becoming awakened to the possibilities of mosquito control or extermination. With the promise of relief from the flights of the marsh species, local work will tell, and the owners of woodlands are filling or draining the pot holes; the local municipalities are looking to the cleaning up of breeding places within their jurisdiction, and in October the Secretary of the Essex Park Commssion and one of his engineers, went over the Orange Mountain reservation with Mr. Renwick and Mr. Grossbeck to determine what work is required to clean up the territory included in the park system.

The Palisade Problem.

Complaints of mosquito troubles from the Palisade region have been received from time to time, and I have had the country examined in a general sort of way at the foot of the bluffs and along the crest, without discovering conditions that accounted for the occurrence of local species. It was finally found from collections made that the species in fault were the salt-marsh forms, and it was assumed that the supply came from the Hackensack valley on a west wind. But this summer the species were troublesome on the crest when there were no marsh mosquitoes in the Hackensack valley, and the assertion is made by those who have observed that the mosquitoes came in on an east and not west wind.

In the early summer I went over a portion of Grantwood, one of the settlements on the Palisades near Fort Lee, at the invitation of the local improvement association, and could find no local conditions to justify any considerable mosquito trouble. To keep the matter under observation, however, I sent Mr. Grossbeck over the entire surroundings on July 25th, and again on August 19th.

instances he located several bad breeding places for *C.* but this did not seem to be the species at fault, and the ; places were well away from the center of population t of the bluff. There was a general agreement that the came in on an east wind, and Mr. Grossbeck, after his t, suggested that New York city might be in fault. The at this point is over a mile in width; there is no salt long its shores, and the city intervenes between that point nearest salt-marsh area, so I was not inclined to fall in s suggestion.

s second visit in August Mr. Grossbeck again covered this , finding west of the crest a few examples of fresh *llicitans.* On the crest of the ridge, however, facing the at species became very much more abundant, and with it amples of *C. tæniorhynchus,* which we had not found on our marshes this year. There was an east wind and the specimens seemed to come in on that, all very d in good condition as if only recently emerged. Mr. k reasserted his conviction that the specimens were New d not New Jersey products, and stated that salt-marsh re clearly visible from the edge of the Palisades, with in the way of a direct flight from the marsh over the he top of the cliff, a total distance not exceeding five

st this point I sent him to the New York area August d he found an extensive salt marsh breeding area at the f the Bronx river. Larvæ were found in numbers, as upa shells and recent adults, and among the larvæ were *C. tæniorhynchus,* together with adults in sufficient num- dicate a fair percentage of the entire output. Now, as ies was not found at all this year on the New Jersey in the areas about the mouth of the Hackensack, and it able on the Palisades, the conclusion that these Palisade s came from this Bronx area was simply irresistible— ld not have come from any other point.

natter was presented to Dr. A. H. Doty, who is in charge osquito work for the city of New York, and he promised that area looked after and taken in hand, a promise that

he has started to fulfill by sending over the area Mr. E Winship, one of his assistants, with instructions to ascerta extent and location of the infested territory.

The attention of the authorities of Bronx Park, and Zoological and Botanical Gardens, was also called to this n and they have promised to co-operate in securing the drain this breeding area, which is, of course, a much greater nu to them than to their neighbors across the river. We ar gradually narrowing the area of infestation and elimi breeding places as fast as they are located. The city of New will continue this work within its own limits until the marsh area is cleaned up.

Sussex and Warren Swamps.

To determine something of the character of the mosquito lem in the hilly, northern parts of the State Mr. Grossbeck two full days—July 10th and 11th—in driving from Ha town to Culvers Lake, collecting in the swamp areas alo Pequest and some of its tributaries and in the marshy areas the borders of the lake. His results were of extreme intere will be of value later, when the problem of dealing witl ditions in that section of the State comes up practically. woodland everywhere, *Culex abfitchii* was found in swar equal the marsh mosquitoes along the sea coast; and usuall one species only occurred.

Abfitchii is a vicious biter, but sticks to its woods cl Once within its haunts and the attack is prompt and fierc pursuit will extend even beyond the edge of the forest. 100 feet from the trees most of them have abandoned the and at 200 feet only those that have had a taste of blood ha for yet a little while. It is quite safe to go to the edge wood and to rest in the shade of the first trees; but at 2 within its precincts the attack begins. All these specimens bred in May from temporary woodland pools and the which emerge in that month, hang on until late August.

This is in the region of the drained swamps where onion other vegetables are largely grown, and Mr. Grossbeck h

Figure XV.

Above: Dr. Nienstadt spreading "Killarvæ" on a breeding pool on Marsh; below: a large pool treated with "Killarvæ," which turns tl *milky for a short time.*

opportunity of noting the character and effect of the ditching done. He reports that many ditches are suffering from neglect, are allowed to grow up and are losing their effectiveness.

In the more open depressed areas, where water was lodged, larvæ of *Anopheles* were everywhere found and with them, usually, those of *Culex territans*.

The character of the country changed somewhat south of Springdale, and more open swamp with cat-tails and tussocks was the prevailing feature. And here while larvæ of *Anopheles* were abundant in the pools, the troublesome adults were all either *Culex perturbans* or *C. aurifer:* sometimes one, sometimes the other; not infrequently both. These would attack and bite hard when their territory was entered; but never followed far, and it was easy to get out of their way.

The marsh between Swartswood Lake and Little Pond is composed of tussocks and high grass, with trees growing along the edges of the stream. The adults in this place were all *aurifer,* and they were present in immense numbers and extremely vicious. Around Culver's Lake both species were found, with *perturbans* far in the lead. As for larvæ, it was Anopheles everywhere and mostly very small. Even the stagnant pools in barn yards yielded no *pipiens.*

An interesting feature of the trip was that during the three evenings spent on hotel porches not a single mosquito was seen or felt. In other words, although there are mosquitoes in great abundance in parts of Warren and Sussex Counties they are mostly of such species as do not readily leave the immediate vicinity of their haunts, and do not make a practice of coming to towns or villages or getting into houses. Of *aurifer* and *abfitchii* this is absolutely true; of *perturbans* it is not.

Experiments with Killarvæ.

In the report for 1906 this material was referred to and the tests made with it were briefly detailed. Dr. Nienstadt was not satisfied that the unsatisfactory results obtained should be accepted as conclusive, and I was quite willing that it should have another trial. I did not believe that it could equal oil in general mosquito

work; but there are some cases where oil is undesirable, an where a cleaner, less offensive substitute would have a distinc field of usefulness. The early woodland species, *canadensis* an *abfitchii* seemed to offer good experimental material, and o April 27th, Dr. Nienstadt, Mr. Brehme and myself treated tw typical woodland pools near Millburn. The practical work wa all done by Dr. Nienstadt, the pools being located by Mr. Brehm and selected by me after determining the character of the wrig gler fauna. There were a number of other pools in the vicinit that served as checks.

The material did not act at all as Dr. Nienstadt expected, an the larvæ persistently refused to die under observation; but noted that the "Killarvæ" in the bottles collected as sample seemed to precipitate the organic material in the water, and I wa quite ready to believe that the larvæ would die later from star vation, as they did.

A week later Mr. Brehme examined the pools carefully an reported a large percentage of the larvæ killed off. There wer yet quite a number present and developing normally; but ther had been a very decided thinning out, which was not found i untreated pools, and which is fairly to be credited to the mos quitocide.

On June 21st, Dr. Nienstadt gave a "demonstration" of th effect of his material at Hoboken, which, owing to a misunder standing, was not attended by any member of the staff.

On August 6th, the material was tested on the salt marshe near Carteret, where Mr. Brehme had located some very fin breeding pools for *Culex sollicitans*. Here again Dr. Nienstac treated several pools, some of them well stocked with larvæ, or of them stocked with fish—the latter being tested to determi the effect on animal life.

The application was liberal, and in a few minutes the lime h precipitated the organic material and formed a white coating o the bottom against which the mosquito population stood shar outlined. Evidently the wrigglers did not like it, and ma their way to the edges and to the shelter of the grasses; but wh we watched they evinced no disposition to die off.

As this meadow was then in process of improvement Mr. Brehme had opportunity to observe these pools later, and he reports absolutely no bad effect on larvæ or other insects, and none on fish. In salt water the "Killarvæ" acts as a prompt clarifying agent, but the chemical reactions seem to be such as not to affect the animal life. Before the larvæ had completed their development the ditching gangs had reached this area and the breeding pools had disappeared.

The conclusions reached from the experiments of 1907 are not materially different from those reached in 1906. Used liberally the material kills wrigglers in fresh water; but it does so less by its direct effect, than by its indirect effect, killing the micro-organisms on which the larvæ feed, and thus starving them to death. The more confined the water area, the more active the insecticide. It is useful in woodland pools against the early spring mosquitoes. On the salt marsh it is good for nothing.

The Minnow Problem.

In the report for 1906 Mr. Wm. P. Seal gives his account of the work done in the attempted introduction of the top Minnow *Gambusia affinis,* into New Jersey. Apparently the experiment proved a failure and was recorded as probably such, so far as ocular evidence went. At present it is not so certain that the failure was as complete as at first believed, because for the first time in history, *Gambusia affinis* was found in New Jersey during the season of 1907.

Mr. Seal placed some 8,000 of the little fish in the tributaries of an ice pond at Westville in the late fall of 1905, and in 1906 failed to find any of them after the month of March. Investigating their possible whereabouts, he found a theretofore unsuspected connection between the pond and the Delaware River, and suggests that possibly they might have found their way to that stream.

During the summer of 1907 he collected in several of the tributaries of the Delaware; but these are generally of such a size and such a character as to make search for small fish that are not

present in large numbers a very uncertain matter. At all he found nothing of the *Gambusia.*

In October, Mr. Henry W. Fowler, of the Academy of N Sciences of Philadelphia, and author of the fish book publis the New Jersey State Museum, found the species in some streams emptying into Delaware Bay and published the foll note in "Science" for November 8th, 1907:

"Professor John B. Smith has called attention to the int tion of *Gambusia affinis* in New Jersey waters as a check development of the mosquito, as neither he nor his assistant met with it in their investigations. It was, therefore, wit siderable interest that quite recently Messrs. H. Walker Har O. H. Brown assisted me in fiding this little minnow in numbers in Teal's Branch of Pond Creek, a small tribut Delaware Bay at Higbee's Beach. We also found it very dant in New England Creek, another tributary of Delawar just north. There it was associated with large numbers of r young or small *Fundulus heteroclitus macrolepidotus, L parva, Cyprinodon variegatus, Menidia menidia notata, Eu tis gibbosus* and *Palæmonetes vulgaris.* The streams men are mainly brackish, though fresh near their headwaters, m less shallow with muddy bottoms, though with a clear eve gentle current. The males of *Gambusia* were equally abu with the females, though the latter were usually larger. accurrence of *Plethodon erythronotus* at Higbee's Beach i interesting."

This occurrence is distinctly interesting: Mr. Seal is in to claim that the species is present as the result of his w 1905 and points to the fact that the State of New Jersey ha thoroughly collected over by the best Ichthyologists of the try for many years, and that Mr. Fowler himself, in the pr tion for his work on the New Jersey fishes collected very c without finding it. Mr. Fowler doubts this conclusion and to the fact that to reach their present habitat the fish had a ney of about ninety miles from their point of introduction. they should make this and establish themselves in such nu as do occur, in the presence of their natural enemies the su he considers very unlikely, while not disputing the possibili

Neither of these gentlemen seem inclined to believe in a recent natural introduction from a more southern point.

With the evidence as it stands at present a positive conclusion is impossible; but the fact is that *Gambusia affinis* has been found under natural conditions in New Jersey in such numbers as to make it reasonably certain that it is firmly established, and that there are other places in the State equally well adapted to it. On this point Mr. Fowler writes: "So far as the conditions at Cape May are concerned I do not think it unlikely but that they may be duplicated in other parts of the State. The *Gambusia* prefers a shallow, sluggish stream with clear water. Those taken by me were found in streams usually with a bottom of deep soft mud, the clear water flowing gently over it. The fish are sociable and were most always found with other small fishes and shrimps (salt water). Altogether it does seem very reasonable to assume *Gambusia* as indigenous to New Jersey when other features of its southern fauna and flora are considered."

Miscellaneous.

The time of the office force was pretty well taken up by the work that has been already reported upon, nevertheless there was a great deal done of an educational character that makes no subjects for report. Such are lectures that were delivered in a number of towns and cities in and out of the State, usually at the instance of improvement societies, and these have done much to impress upon the public the thoroughly practical character of the work intended and under way. There has been a steadily continuing demand for the Mosquito Report of 1902, the edition of which is now nearly exhausted, and many letters have been received and answered on matters relating to mosquito work. Especial effort has been made to continue in touch with the sanitary authorities, and especially the boards of health in the larger cities, which are recognizing more and more the importance of their duties in this campaign.

Special investigations have been made by Mr. Grossbeck, other than those mentioned elsewhere in the report, at Mount Holly and

Riverton, Burlington county; at Westville, Camden county Piscataway, Middlesex county, and in and about Trenton, M cer county. On all of these works reports were made to the ties concerned, and some of these were acted upon.

Along the seashore numerous points were visited by Brehme at various periods, and an especial investigation was r at Sea Girt, where, by the bye, there is no local mosquito br ing on State property. On two occasions points on Long Is were visited at the request of communities, who paid his expe and there have been other requests for his services that could be met.

Other States are becoming ever more interested in the c paign carried on in New Jersey, and are following her lead. New York City is a good second in the character and extent of the w under way; Pennsylvania has provided for a mosquito su of that State; Maryland has begun work, especially in and a the city of Baltimore, and from several other States request information as to methods have been received. In medical cieties, sanitary and public health associations, and in all bc connected with hygienic work of any description, the mosq subject has come up for discussion. It has been made the sul of magazine articles, and now receives universal respectful sideration in the newspapers. The time is ripe for a vigo prosecution of the campaign.

NOTES ON THE MOSQUITOES OF THE SEASON.

BY JOHN A. GROSSBECK.

The season of 1907 was on the whole a normal one, tho excessively dry for a time in the north, and, except for an o sional local outburst, most of the species of mosquitoes develc in their usual numbers without attracting any especial attent For one usually uncommon species, however (*Culex perturba* the season—or perhaps it may have been the previous one—t have been peculiarly favorable, since it was found in practic all sections of the State, and in some localities in painful n

Figure XVI.

np area for breeding *Culex perturbans;* the larvæ are in the
grass roots.

bers. This is the one mosquito in New Jersey with which we were entirely unfamiliar in the early stages. It is true that we do not yet know the larvæ of *Culex saxitilis* and *pallidohirta*, but both of these were bred from pupæ collected in the ordinary way from transient pools, and, therefore, sufficient is known of their early life to enable us to say that it does not differ from that of their allies. Prior to 1907 the discovery of the larva and breeding habits of *Culex perturbans* was a matter of scientific interest only, and only such time as was not taken up with more important matters was given to a search for them. But since it became of economic importance in one of New Jersey's pleasure parks, no effort was spared to determine its natural habitat. Persistence was rewarded with success, and its life history, with methods for its control, are detailed on another page.

As heretofore, the salt marsh mosquitoes were the principal offenders, and dominated the undrained parts of the coast, as well as the adjacent territory for miles inland. Owing to the lateness of the season the larvæ on the salt marsh developed slowly, and it was not until the middle of May that the first heavy brood, composed almost entirely of *Culex cantator*, was on the wing. From that time on, breeding was more or less continuous until late in the fall. *Culex sollicitans*, as is usual, almost completely replaced *cantator* in the latter half of the summer.

Aedes aeniorhynchus was taken only once during the summer; two fresh individuals at Grantwood, on August 19th. None were found to develop on the New Jersey marshes, so it was supposed these came over from the New York side. Later, on August 30th, larvæ were collected on Randall's Island in New York, which proved beyond a reasonable doubt that the specimens taken at Grantwood came from that source.

Anopheles crucians was hardly noticed during the year, except in a few examples in the larval stage toward the end of the summer, while *Anopheles crucians* was not taken at all.

Of the inland local mosquitoes, *Culex pipiens* was by far the most abundant, though locally *C. perturbans* far outranked it in numbers. The principal outbreak occurred in the city of Paterson and vicinity, between August 15th and 18th, where after a dry spell, followed

by frequent showers, *pipiens* developed in almost every section and came to maturity almost simultaneously. The inhabitants of the eastern and southern portions of the city suffered most severely, and they described the occurrence as terrible. Screens seem to have been practically of no avail in keeping the pests from entering dwellings, and sleepless nights were the rule throughout the affected area.

At Grantwood, on the Palisades, a breeding spot for *pipiens* was discovered which in the number of individuals it developed at one time stood unequalled so far as our experience is concerned. Here in a pool measuring 12 feet wide by 25 feet in length larvæ and pupæ crowded the surface so densely that at first it was thought a thick brown vegetable scum had formed over the water. A disturbance created a commotion which lasted for several minutes before the last of the larvæ could force its way through the living mass away from the apparent danger point. A dip of an ordinary water glass from this pool brought up between two and three thousand wrigglers!

Owing to the lateness of the spring the species of *Anopheles* were late in appearing, and not until the middle of July were larvæ found in any numbers, and then they were exceedingly small as a rule. *Punctipennis* was not as prevalent as heretofore; but *maculipennis* was rather unusually abundant. It was taken as a larva in several places in Warren and Sussex counties July 9th to 11th, and as an adult at Trenton, August 8th and October 10th, Paterson September 8th and Millburn October 1st.

Culex Perturbans.

The breeding habits of *Culex perturbans* having been at last discovered, a history of the search in New Jersey may be interesting.

Our first knowledge of the species came from Mr. J. T. Brakeley, of Lahaway, Ocean county, who, on May 27th, 1903, captured about twenty adults. His attention being called to the desirability of obtaining larvæ no pains were spared in collecting and noting the habits of the adults and in scouring the numerous

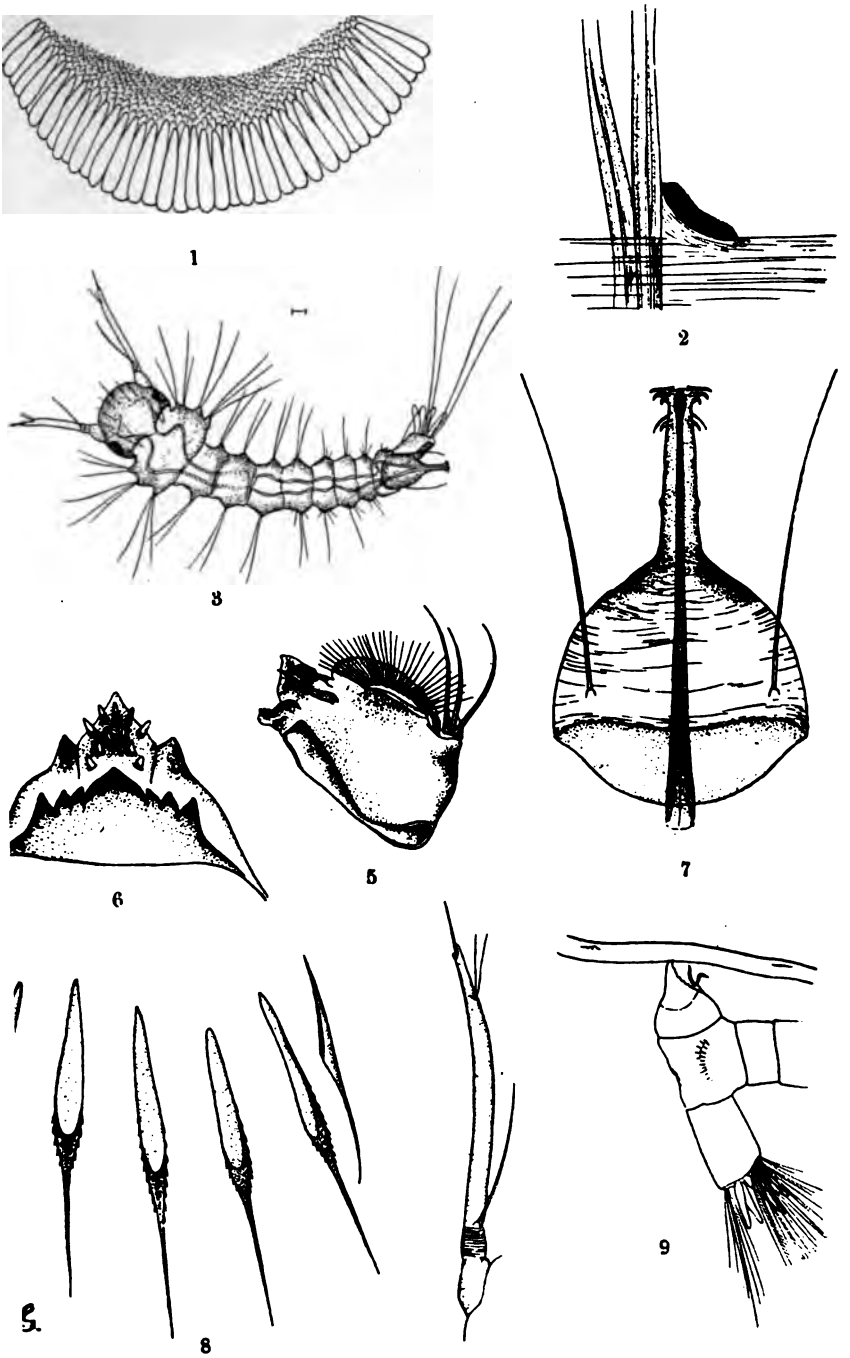

Figure XVII.

1, Egg-boat of *Culex perturbans;* 2, its position on the surface, resting against a grass stalk; 3, larva just out of egg; 4, its antenna; 5, mandible; 6, mentum with hypopharynx; 7, anal siphon; 8, lateral patch of scales; 9, shows how larva is *attached to grass root;* all more or less enlarged. Original.

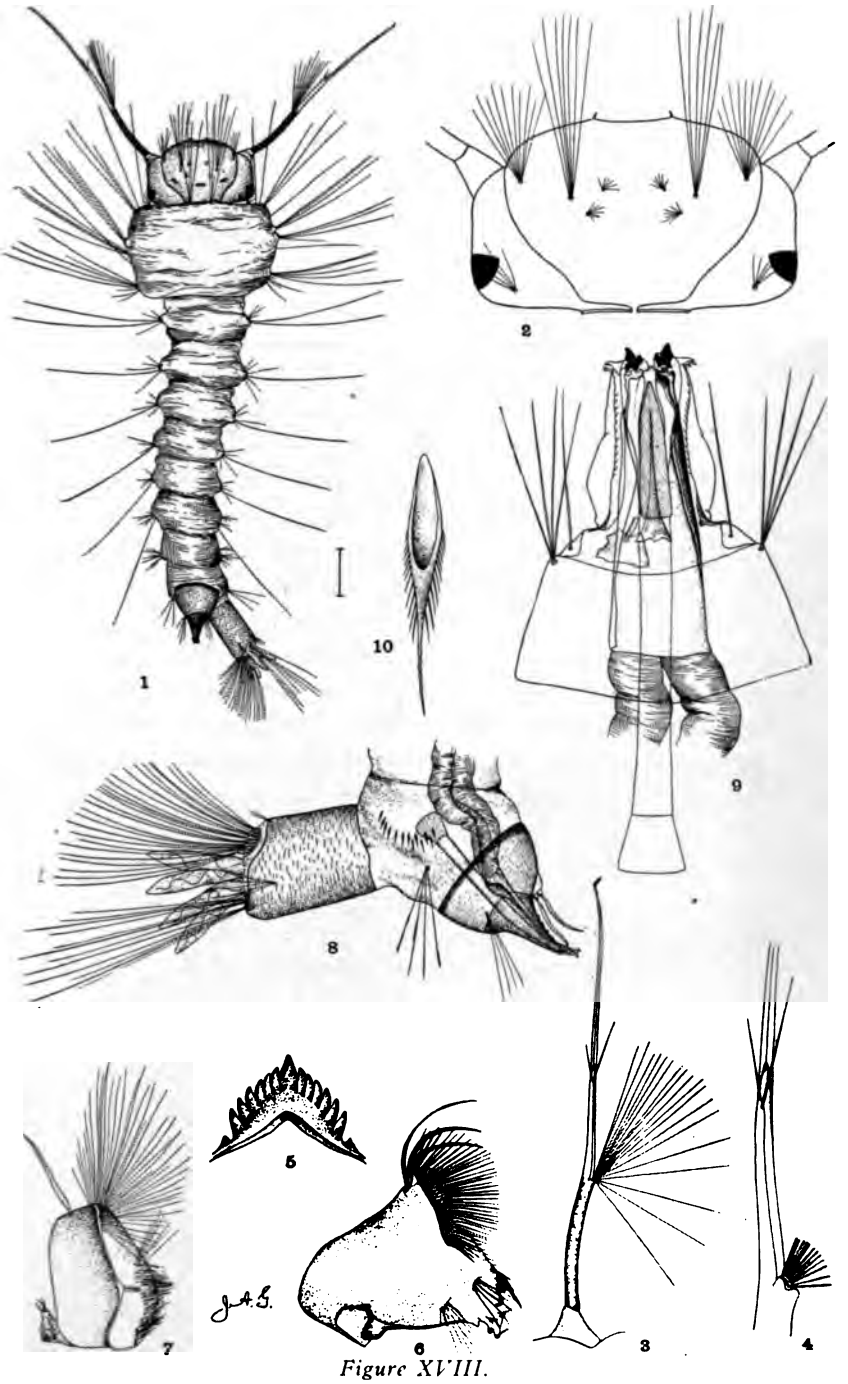

Figure XVIII.

1, Larva in 4th stage; 2, head showing position of hair tufts; 3, antenna; 4, **part of same, yet more** enlarged; 5, *mentum*; 6, mandible; 7, maxillary **palpus; 8, *caudal segments of larva*; 9, anal** siphon; 10, a single lateral scale; ***all more or less enlarged.*** *Original.*

water areas at and near Lahaway in an effort to locate the early stages. Fifty to one hundred adults were easily taken in the course of a single evening, but not a trace of the larva was discovered anywhere, though the search had been thorough and persistently carried out. At the end of the season's work Mr. Brakeley concluded that they must be migrants from some other place, and this opinion was strengthened by the fact that they appeared at the same time and apparently came in with the salt marsh mosquitoes.

On July 21st of the same year, several females and one male were taken at Lake Hopatcong, and on the 29th of that month a female with developed ova was caught in the Moonachi woods near Carlstadt.

Other captures in 1903 came from Cape May, July 28th, August 11th, and September 21st; Chester, Morris county, August 9th; South Orange, August 26th and Arlington. In none of these places were more than three or four specimens collected.

In 1904 and '05 not an adult was secured anywhere except at Lahaway, and there they were present in their usual abundance. On June 4th, of the later year, a male was among the captures:—the second specimen of that sex taken. Search for the larva was continued in these two years, and particular attention was paid to the cedar swamp between Barnegat and Manahawken, where it was supposed that they might breed and migrate to Lahaway. Areas to the south and west of Lahaway were also explored; but in no place was even as much as an adult found. In searching for larvæ no body of water was too small or too large to be passed without notice; with a net the surface and the bottom were swept, stones in the water were overturned, taken out and inspected, logs, branches and limbs of trees were drawn out in the hope of finding them clinging to their surfaces; the bottom material was scooped up and closely scrutinized, weeds and scums were investigated, and plant stems were even split open to see whether they contained larvæ; in short everything in the water, animate and inanimate was examined; but without success.

From the beginning the capture of *perturbans* so far inland as Lake Hopatcong rather opposed the idea that the species bred only along the borders of the salt marsh, and the fact that a male

was among those taken, was almost convincing to the contrar Again, the fact that a male was taken also at Lahaway, point toward local breeding; but a decided argument that they did n breed at Lahaway lay in the fact that none of the females tak there showed traces of developing ova—a peculiarity true also the salt water species that migrate from the marshes. Concer ing the habits of the adults Mr. Brakeley says: "They are fou all over, in the woods, in the open and on the cranberry bogs a get into one's ears and eyes; they get into the bed room and ir the dining room and at the table they go for the ankles."

In 1906, adults were encountered in some numbers in the Gr Piece meadow on August 27th, congregated over an acre or t of territory in the center of which was a large pool of wa rather thickly overgrown with vegetation. Heretofore this p had yielded only *Anopheles* and *C. territans;* but now it seem obvious that it harbored *perturbans* as well. The mosquitoes w most abundant around the edges of the pool and disappeared co pletely at a distance of 150 feet from it. The most diligent sear however, failed to disclose a single larva of this species—all ha ing apparently reached maturity. From a number of adu which were captured and confined in breeding jars, a single e boat was secured on September 10th. This hatched two days lat but the resulting larvæ died a week after emerging, because th had not found the conditions suited to their existence. Yet t pails in which they were kept were provided with earth, ston decayed wood and pieces of sod. We had now, however, associ ed the adults with a particular kind of breeding area, and we able to recall similar water areas at all of the points where adu had been taken. Furthermore, an egg boat could not pass t winter in that stage and if the adults hibernated, Mr. Brakel would surely have found them in his cellar or barn collecting du ing the winter; so the only alternative was that they must hib nate as larvæ. Therefore, we concluded, that search in the la fall or early spring would most likely secure them. Unfortu ately the pool in the Great Piece Meadow dried out in the fall 1906, so the hope of obtaining larvæ from that source was d stroyed. However, the field of search had narrowed down fro

the entire water area of New Jersey, to small permanent bodies of water with plenty of vegetation.

The first record for 1907 came from Lahaway on June 17th, where Mr. Brakeley took several adults. Later they were found in large numbers at Trenton, where in evenings spent at "White City Park" from twenty-two to thirty were taken at single sittings between July 30th and August 8th. Other adults were taken in small numbers at Grantwood, Westville, Paterson and New Brunswick. At Springdale and Culver's Lake they occurred very commonly on July 10th, in company with the *C. aurifer*, and at Lahaway they were present in such enormous numbers that on one ocasion Mr. Brakeley took three hundred examples in fifty minutes. These were collected at the corner of a large lily pond just as night was falling. Mr. Brakeley believes that the species is arboreal in the day time, descending only as dusk comes on, and he bases his belief on the fact that in all his wanderings at Lahaway he has never taken an adult during the day. However, I took a few specimens there on August 1st, but the number was as nothing compared with the hordes which are present in the evening. In is interesting to note also that while they appear in swarms only at dusk, they disappear or at least materially decrease in numbers soon after dark and still later fall off almost entirely. At Culver's Lake, Springdale, and in the Great Piece Meadows they were common at all times during the day and did not hesitate to bite.

With the species so numerous at Lahaway it seemed to be by far the best place to search for larvæ, and on July 31st I went there to begin the search. Mr. Brakeley accompanied me during the first half day to point out the various water areas on his place. The first was a small pond about 25x35 feet and from 6 to 30 inches deep. The central portion was grown over with water lilies, two of the sides were bordered by a solid bank, while the other two were sloped off and supported a thick growth of vegetation in the shallow water. It appeared to be a typical *Anopheles* breeder, and a sweep of the net through the water after these, brought up an egg boat of *Culex perturbans*. Thus we had at the very outset discovered at least one of the breeding places of *perturbans*. But did they always breed there? Mr. Brakeley claimed not, as he had

time and again thoroughly investigated this pond and had nev gotten a mosquito larva of any kind in it. A few minutes furth search, by gently pressing the vegetation beneath the surface the water, revealed three additional egg-boats. We next inves gated a larger lily pond on the banks of which Mr. Brakeley h caught his 300 adults in fifty minutes. This was alive with sm fish that were able to get to almost every point in the pond; nev theless, along the shallow borders, I took egg-boat number fi A sixth egg-boat was taken from a sphagnum pond where fished for *Corethrella brakeleyi.*

On August 1st I made a more thorough search of the sm pond wherein four boats had been found on the day previous. I part of the water's surface was left unexamined, and in two ho 59 egg-boats were collected. All were found for three feet c along the shallow edges, where the vegetation was thickest and a grassy nature. Along the other two sides the lilies grew cl up to the edges, and here and in the center of the pond absolut nothing was found.

The egg-boats were often clustered around a single stalk grass, forming a star of from four to nine points, one end of t boat being drawn high up along the plant stem by capillary attr tion, while the opposite end points directly away from the cent

Every part of the pond was searched for larvæ as well as eg boats, but with the exception of one young larva, apparently j out of the egg, nothing was found. For a pond of this kind t water was remarkably free from insect or other life. In all, o small fish, three tadpoles, two dragon fly larvæ, fifteen sm Dytiscid beetles, and one larva of *Uranotaenia sapphirina* w taken from it.

On August 6th, an open swamp, six or seven acres in extent, Trenton adjoining Spring Lake, and which was previously s pected of being the source of the *perturbans* supply for the Wh City Park, was examined for eggs. In such an immense area a with the species so much less common than at Lahaway, the ta was not a light one and at the end of half a day's work on twelve boats were collected. Most of these were fragments, fou at widely separated places. On August 8th and 12th, other par of this swamp were examined, and eggs were found all ove

though in certain spaces where the vegetation was not so thick or in free water, absolutely no traces of any could be seen. In all 57 egg-boats, complete or fragmentary, were taken on the Trenton swamp area. On August 8th a larva in the second stage of development was fished up with the bottom material, but continued searching in the same place failed to turn up additional specimens.

All the egg-boats collected at Trenton were given up to experimental purposes in an endeavor to bring the resulting young larvæ to maturity; but while all were failures it may not be uninteresting to note the various conditions to which they were subjected. First, it was found uterly impossibly to carry the egg-boats for even a short distance, because unlike those of *pipiens* they sink readily and apparently do not hatch when thus submerged. For this reason the experiments were carried on in a protected place near the swamp itself. A series of five two-quart jars three-fourths filed with water served as breeding places, and on August 8th fifteen boats were equally divided between them. No. 1 contained only water taken from the swamp; in No. 2 was placed two layers of turf; a third contained one layer of turf and a three inch layer of vegetable mould from the swamp; in No. 4 was a number of lily stems and in No. 5 an entire plant of arrow-leaf. On August 12th, the following was noted: No. 1, eggs not yet hatched; No. 2, larvæ hatched out and all dead; No. 3, one boat unhatched, others hatched and all larvæ dead; No. 4, no eggs hatched; No. 5, larvæ hatched and dead. Additional egg-boats were placed in each, and another jar, No. 6, was added, which contained grass with all the roots, while in No. 1 was put a seven inch layer of silt. August 16th, the following conditions were noted: No. 1, an active brood of young larvæ, burrowing some three-fourth inch down into the silt where they could be seen in small crevices wriggling vigorously; No. 2, a lot of young larvæ swimming about in the free water—none entering the turf; No. 3, a large brood of larvæ, all dead or nearly so; No. 4, larvæ hatched and all alive; none attached to lily stems; No. 5, larvæ out and all dead; No. 6, larvæ out and all dead. On August 26th, after a period of ten days, examined all the jars and found everything dead.

After this, experiments were abandoned, and it was decided to wait until late fall, to give the larvæ a chance to develop, and then to fish the small pond at Lahaway. Meanwhile Mr. Brakeley had been giving the subject some attention, and on September 21st, after fishing the pond in vain with his graduate, he pulled up a plant of tear-thumb grass, and from the roots washed out a larva in probably the third stage of development. Two other smaller larvæ were secured in the same way, and all were sent to the laboratory. With this information I went down to Trenton on September 27th, and with a small net fished the bottom material, where I had previously found eggs. When the water had finally trickled through the cloth, a mass of brown silt was left and in this were two well-grown larvæ. Others were taken in the same way, but it was not until the bases of the tussocks were swept that larvæ were really gotten in some numbers. Collecting was slow, on account of the fact that each sweep of the net would bring with it a mass of partly decomposed vegetable matter, and the fine silt would clog the meshes of the cheese cloth net. In all forty-seven wrigglers were taken in two hours, and they ranged in size from those apparently just out of the egg to those one-fourth of an inch long, and representing stages from one to four. The great majority were of the largest size. No larvæ were taken at a depth less than six inches from the surface, and most all at a depth of ten inches and over. Specimens could be gotten as far down as the net could be forced through the matted vegetable roots. Mr. Brakeley, continuing his washings, sent in six larvæ on September 26th, four on October 1st, four more on October 3rd, and eleven others on October 11th. Most of these were small, only three being in the third stage. Collections at Trenton turned up eighty larvæ on October 1st, one hundred and nine on October 3rd, forty-two on October 9th, and forty as late as November 1st.

Habits of the Larva. As before noted, the larva is not dependent upon the outer air for its existence, and, after once leaving the surface from the egg, probably never returns to it until it has assumed the pupal stage and is ready to emerge as an adult for flight in the open air. Unlike the larvæ of certain other mosquitoes in New Jersey, which rarely come to the surface, the larval

gills are not unusually developed, though they are provided with obvious trachea. It seems that in this case the wrigglers are able to obtain a supply of oxygen through the open cellular tissue of the roots of certain grasses, which they pierce with the curiously shaped air tube that is especially adapted for this purpose. They do not permanently anchor themselves to one spot on the root, but can very readily detach the tube and move to some other place. At the laboratory over one hundred larvæ were put in a two gallon jar into which was placed a portion of a tussock around which the larvæ were collected in the swamp. In a short time most of them had disappeared within the sod, though a number worked their way through and came out in the crevices on the other side where the sod rested against the glass, giving a splendid opportunity for study. Here they were seen to attach themselves to the grass-roots and sometimes remain in the same position for days; but would quickly let go and wriggle away if disturbed. Before piercing the plant tissue the larvæ often move along a root, tipping the tube against it as if feeling for a soft spot. After such a performance a favorable spot was usually located in a crotch where a rootlet divided from the main branch.

Just how far the larvæ go down into the swamp in winter, if they go down below the point at which they were collected at all, is not known at this time, and how the adult emerges from the pupa in late spring, is also a question which cannot be answered at present.

In collecting at Lahaway, November 10th, Prof. Smith found that the heavy rains had raised the July level of the small pond where I found the egg-boats over six inches, and that this had resulted in lifting the bottom vegetation so that it floated; leaving about six inches of open water between the bottom of the sod and the mud of the pond bottom. By getting the net through the floating sod and sweeping the root mass underneath, larvæ were obtained in every dip; but no larvæ were found in the bottom mud. The roots, then, are essential to the larvæ and they seem not to occur where none are present. This is also borne out by the observations made by me in the Trenton swamps.

Breeding places for perturbans and methods for their control. ***Culex perturbans*** is probably the nastiest of the inland mosquitoes

with which we have to deal. It has for its home just those k of swamps that are free from other mosquito life, and prol also the shallow borders of lakes which support a heavy vege growth. Such places are usually well supplied with predac water insects as well as other natural enemies of mosquito l and even *Anopheles* is unable to maintain itself to any extent *perturbans* selects for its breeding, spots so thickly overg with vegetation that very few insects and no fish are able to p trate. Thus the egg-boats are left unmolested and the larv soon as hatched bore down into the mass of roots away fro ordinary foes. Hard bottomed tussock swamps probably a breed *perturbans*.. Such swamps as are apparently botton that is, they are so boggy that solid footing cannot be gott any depth, serve as the haunts of the larvæ of that species.

Owing to the fact that the larvæ are not dependent upo mospheric air for their supply of oxygen, and that they pene silt for some distance, they cannot be reached with the ordi petroleum oils and lime mixtures. Draining the swamp by n of deep ditches, or the removal or thinning out of the veget to give fish and other enemies an opportunity to enter wou the most effective method and, in the long run, the least expe in eradicating breeding areas. Nevertheless the insects ar altogether beyond our reach as the following experiments, ca on under the direction of Prof. Smith, will show.

Experiments with Phinotas Oil.—October 7th: A small am of the oil was put into a jar containing about one gallon of v and sixty larvæ. It had no immediate effect upon them, b two or three hours afterwards such as were swimming free i water were seen to be sluggish in their movements. The day, about twenty hours after the application, the water and sod were examined, and while most were dead three larvæ washed from the sod, which were active and swam freely changed to fresh water.

An approximately similar amount of the oil was put into containing two gallons of water and one hundred larvæ. Th in this case was forced down into the water by means of a pi and bulb, whereas in the first jar it was put in gently. The terial sank to the bottom very slowly and it was fully two h

before it actually enveloped the sod. The next day, twenty hours afterward, only two larvæ were alive from the sod; the remainder were dead.

October 10th: Went to Trenton and selected a spot in the swamp where larvæ were present—six having been taken by the first dip of a net and four in the second. Here I staked out an area twelve feet square and from a sprinkling can poured one gallon of Phinotas oil evenly over the surface. The area, as is the whole swamp, is thickly overgrown with vegetation and at this time of the year was worse than in summer because of the dry grass falling down and forming a layer over the surface which must be penetrated before the grass roots, where the larvæ cling, are reached.

October 15th: Thoroughly examined the area treated with Phinotas oil on the 10th. Two hours were spent in fishing around the tussock tufts, as well as elsewhere, and in that space of time I secured only four larvæ—two dead ones and two that were very much alive. Thus it appears that dead larvæ are not so easily secured as are live ones since larvæ were really abundant before the application.

About ten feet distant from the area treated with Phinotas oil larvæ were as numerous as previously, even though a thin coating of oil was present over the surface where it had spread from the treated part.

This Phinotas oil was described in the report for 1902, and it is a most powerful destroyer of larval life. Unfortunately it kills fish and other aquatic life as readily as it does wrigglers, and therefore is not suitable for general use; but in cases like this it would seem to be just the thing and, while we may not be able to kill off all the larvæ in a swamp, we can at least reach and destroy so large a proportion of them as to reduce the pest to harmless numbers.

Description of the Larva

Length 6—7.5 mm.=.24–.30 of an inch from head to end of ninth abdominal segment. It is a robust wriggler resembling in life the larva of *Culex jamaicensis*. In color it is white, tinged

with a clear transparent green which is often the predominating hue. The head is pale brown, much broader than long, rounded in front and flat at the sides; four large and four small tufts of hair arise from the vertex, two of the large ones of 6 or 7 hairs each from the central portion, between which the four small tufts are situated, and one of 10 or 11 hairs near the base of each antenna. Of the small tufts the anterior pair are each composed of 6 hairs, the posterior pair of 7 each. There is also another pair of moderate sized hair tufts near the base of the head just below and inward of the eyes; these are composed of five hairs each. The eyes are remarkably small, black and placed far down on the sides of the head. The antenna (fig. 18, 3 and 4) is very long and somewhat filamentous, infuscated at basal third and almost colorless beyond; a large tuft of 18 to 20 long hairs arises from an offset at the basal third and from this point the shaft is continued for some little distance, apparently as a thickened side of a hollow tube which is open on one side to the apex of the main shaft; this apex is terminated by two long needle-like spines and the filamentous process has at its end a very small articulate spine. The mentum (fig. 18, 5) is triangular in form with a deeply excavated base and six large teeth on each side of an apical one besides a small tooth which is sometimes present near the base. The mandible (fig. 18, 6) presents much the appearance of that of the ordinary *Culex* (sens. lat.) type, but has three curved dorsal spines and the teeth are small and situated some distance back from the apex. The maxiliary palpus (fig. 18, 7) offers little that is peculiar, but the subapical spine is exceptionally long and blade-like and the basal process is rather small with curved apical teeth.

The thorax and abdomen are normal in form, the former with the usual number and location of long hair tufts; but the abdomen has only one tuft of two hairs on each side of the first segment, the following five each having but a single long lateral hair, while segments 7 and 8 have none except the several short hairs which are common to all segments. The eighth segment bears the lateral patches of scales, each of which is composed of from 12 to 15 scales arranged in an irregular, partly double row. The individual scale (fig. 18, 10) is lanceolate, with a long apical spine and

fringes of small spines at the sides. The ninth segment is somewhat variable in length but is always longer than broad and is completely encircled by a light brown chitinous ring. The ventral brush is normal but the dorsal hair tufts are four in number instead of the usual two. The anal gills are slightly longer than the width of the ninth segment and are supplied with obvious trachea. The breathing tube (fig. 18, 8 and 9) is a highly complex organ representing an extreme modification of the ordinary anal siphon. In color it is pale brown, with the extreme base and apical half strongly infuscated. From a dorsal aspect (fig 18, 9) it is bottle shape* with the basal half greatly dilated. From the side the apical half curves slightly dorsally and two long blade-like spines arise from large papillæ situated on a distinct dorsal offset. The constricted portion of the tube is provided within with projecting flaps which appear to hold the inner chitinous tube in position. The apex of each lateral set of flaps is furnished with six horizontally extended hooks. The inner tube, to which the trachea are attached at its base, is a complicated structure in itself, being composed of several distinct pieces One small elongate piece forms the ventral wall, while another much larger piece extends curvedly from one edge to the other. From the apex of the tube thus formed extend two small tubular structures terminated at their apices by an articulated, irregular, corneous piece which by the action of the long, somewhat chitinous piece coming from the interior of the eight abdominal segment is capable of being thrust forward and horizontally outward. Another separate little piece on the dorsal side of the main inner tube has a serrated edge which is plainly seen from a side view of the entire siphon.

* * * * * * * * * *

Culex sylvicola was taken only twice as a larva, once on May 4th in the Orange Mountains, a new locality for the species, and again on May 7th, in the Livingston Park woodland swamp. It proved to be much less common than in past years.

Culex abfitchii has continued to be a pest in certain wooded sec-

*The drawing was made from a balsam mount, and is consequently much broader and the outline distorted.

tions of the State. At Livingston Park they were present in limited numbers; at Short Hills, though abundant, they were not nearly so bad as in 1906; but in portions of the Great Piece Meadows, and in certain timber regions along the Pequest River in Warren county, they appeared in great swarms which made it almost impossible to stay in the woods.

Culex canadensis occurred quite generally throughout the wooded portions of the State; but was not exceptionally abundant anywhere, and of *C. sylvestris* the same may be said except that it breeds in the open rather than in the woods.

Culex abserratus of which a number of specimens were taken in New Jersey in both 1905 and 1906, appeared this season in comparatively large numbers and was found at Short Hills on the Orange Mountains, and in the Livingston Park woods. As previously recorded it is the first of the spring species to appear, and as a larva almost disappears before *canadensis* or *abfitchii* begins to hatch.

Culex aurifer breeds in much the same sort of swamps as *C. perturbans* and as adults the two are often found together. This fact previously led us to search for *perturbans* in *aurifer* breeding places; but without success because we were seeking a free swimming larva. In the same pool where *perturbans* was first supposed to breed, a large number of *aurifer* larvæ and pupæ were found on May 11th, 1907. A single larva was taken also at Short Hills, and as an adult it occurred in swarms at Swartswood Lake and Springdale, Sussex county, on July 10th, and in smaller number at Culver's Lake on the same day. This species, like *C. abfitchii*, remains on the wing for the greater part of the summer, although there is but a single spring brood.

Culex melanurus is recorded as occurring as a larva as late in spring as May 5th, and it was believed that there was no recurrence until September or October. In 1907, however, a number of large larvæ were taken at Lahaway on August 1st, and in the same pool was a full brood of very young larvæ which had apparently just hatched. A dozen single egg-shells and a cluster of five and another of twenty-seven were also fished from the pool, which indicates that the egg laying habits of this species are similar to the others of the *pipiens* group to which the adults belong.

It may be, then, that the species breeds continuously during the summer. The eggs are laid in agglutinated boat-shaped rafts which float upon the surface of the water, and the individual eggs in outline are the same as those of *C. pipiens;* but are slightly larger, darker in color and with the surface more coarsely papillose.

Marriage Flight of C. cantator. Until June 15th, *C. cantator* adults were seen in Highland Park, near New Brunswick, only in twos and threes, and in one case there were half a dozen; but on this date females were found all over the garden and porch and a dozen were dancing over the window panes in the hallway. It was beginning to grow quite dusk when I discovered a swarm of about 200 male adults dancing in the air about 7 or 8 feet from the ground. This I watched until dark in the hopes of seeing without question the females carried away by the males. At intervals of every few minutes there would be a commotion in the swarm and sometimes (not always) something would leave the swarm in a straight line. Except once it did not appear, however, that there was more than one mosquito leaving the mass. In this case it was either a male and female *in copula,* or a single frail insect larger than a mosquito. The increasing dusk at the time of this incident was the cause of my not being positive. That there were many female mosquitoes near the swarm was evidenced by the fact that I was continually being bitten by them at the time, and I was lying directly beneath the swarm using the sky as a background.

Though the mating of the sexes was not positively witnessed, it is more than probable that this was the purpose of their congregation, and it is therefore interesting to note that the nearest place that these mosquitoes could have bred is on the Raritan meadow, about five miles distant in a direct line.

Query: Did the female mosquitoes return to their breeding grounds when fertilized, or did they die without ovipositing?

Little has been seen of the species of *Corethridæ* during the season of 1907. *Sayomyia albipes* was taken once from a woodland swamp at Westville on July 5th. *Corethra cinctipes* occurred rather commonly in all spring collections of woodland mosquitoes; but nothing that is new has been added to its life history.

One species of this genus new to the State, *Corethra lintneri*, was taken from woodland pools at Short Hills on April 30th, and adults hatched on May 15th and 16th. The larvæ were taken in some numbers in company with *canadensis, abbitchii* and *abserratus* and were supposed to be those of *C. cinctipes* which they exactly resembled; being perhaps a little more pink in color and slightly smaller. Not until adults emerged was it discovered that it was a new species and then there were no larvæ left. The adult may be distinguished from *Corethra cinctipes*, the only other representative of the genus known to occur in the State, by its pale yellow color and darker thorax and by yellow, unbanded legs.

Detailed description of the Adult. Length 4.5–5mm.=18–.20 of an inch. The head is pale yellowish to fuscous; both pairs of palpi and short proboscis fuscous; antennæ in female slender, setose, pale yellow, darker apically and with a ring of fuscous at the base of the joints; in the male plumose, the shaft ringed brown and yellow, the fine, long hairs brownish. Thorax yellowish-brown in the female, fuscous in the male and clothed rather scantily with long golden yellow hairs especially posteriorly; two nude lines slightly darker than the rest of the thorax begin at the anterior margin of the mesonotum and extend backward to a little beyond the middle. Pleura dirty white to slaty gray. Abdomen of female yellowish, irregularly marked with brownish, especially laterally; of male yellowish with brown basal bands which become broad and triangular in form at the sides, and tend to completely cover the apical segments; pale yellow hairs are evenly scattered over the surface in both sexes. Legs yellowish; a diffuse brown ring just before the apex of the femora; end joints of tarsi becoming brown apically; last joint wholly brown. Claws of male sickle-shaped with a long, simple, median tooth and a somewhat shorter, basal serrate tooth within the curve; the posterior claws have in addition a fine, long, spine-like branch outside the curve. The female claws are smaller, with a single, basal, serrated tooth and are alike on all feet. The wings are hyaline, with the veins and margins clothed with long yellow, hair-like scales.

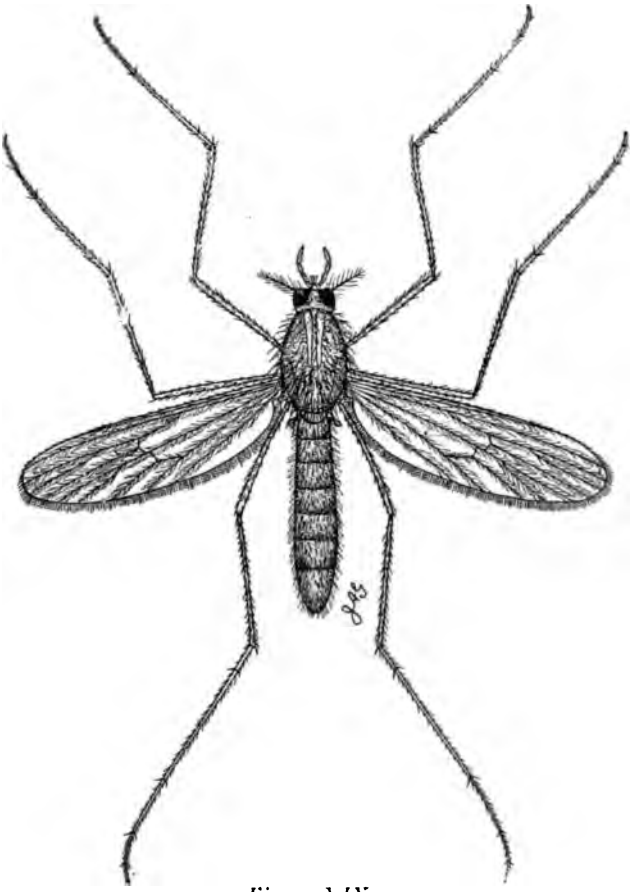

Figure XIX.
Corethra lintneri **Felt; greatly enlarged. Original.**

REPORT

OF THE

ENTOMOLOGICAL DEPARTMENT

OF THE

New Jersey
Agricultural College Experiment Station

New Brunswick, N. J.

BY

JOHN B. SMITH, Sc.D.

For the Year 1908

PATERSON, N. J
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1909

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REPORT OF THE ENTOMOLOGIST

Report of the Entomologist

By John B. Smith, Sc. D.

General Review.

The meteorological conditions of the season were abnormal throughout the State and materially affected the development of the crops and of the insects that infested them. The long drought after the heavy rains of May was very favorable to the development of scale insects and in those localities where, in 1907, it was boasted that the San Jose Scale had disappeared, its startling increase in 1908 brought dismay and serious injury. In spite of the warning that the disappearance of the insect was only apparent, some growers made absolutely no preparations to meet it and suffered accordingly.

The testing of insecticides was continued during the season and is reported upon later. The practical results of the observations are embodied in Bulletin No. 213 issued in September, 1908. The study of the root-maggots was continued and work on certain strawberry and sweet potato pests was taken up and in part completed. Cranberry insects received some attention and orchard work was continued as usual.

During the year many institute and other agricultural meetings were attended and lectures were given on a variety of subjects connected with the work of the Department. The meeting of the Drainage Committees at Washington, D. C., and Trenton, N. J., were attended and lectures were given, descriptive of the work done in New Jersey. The meeting of the American Association for the Advancement of Science was held in Chicago during the Christmas holidays of 1907 and, in connection with this, the Association of Economic Entomologists and the Entomological Society of America also held their sessions. In all these the entomologist took part to keep up with the work done throughout the country.

The matter of the purity of insecticides sold to farmers is an extremely important one and the State regulations on the subject vary greatly. At the invitation of a committee from the Association of Economic Entomologists a meeting was held in

New York City on June 18th, in which representatives of the leading manufacturers took part, at which chemists from the United States Department of Agriculture and some of the Experiment Stations were in attendance, and at which there were entomologists representing all sections of the country.

At this meeting a bill was agreed upon for presentation at the next session of Congress on the lines of the pure food law and which, it was agreed, would be just to all honest manufacturers and to the consumers as well. In all these discussions the writer took part.

During the winter and after the Chicago meeting I visited Decatur, Illinois, and spent a day in the Dr. Barnes Collection, one of the most important in its line in the United States. Through the kindness of Dr. Barnes a large number of specimens was added to College collection, and many of these of species not before represented.

The collection of insects for the Newark Shade Tree Commission was completed and is now on exhibition in their office. A paper on the usual shade tree pests illustrated by two colored plates was prepared for the State Forester as part of a general bulletin on the topic. Attendance on the various scientific society meetings in Newark, New York, Brooklyn and Philadelphia has been continued, and all new information obtained has been used for the benefit of the Station work.

There has been no change in the staff and Mr. E. L. Dickerson as assistant to the State Entomologist and Messrs. H. H. Brehme and John A. Grossbeck assistants in the mosquito work have cooperated in all respects with the general purposes of the Department.

The correspondence has not decreased during the year, covering 3,100 pages of letter book during the fiscal year extending from November 1st, 1907, to October 31st, 1908, and representing over 4,150 separate communications. Circular letters are not included in this record.

GYPSY MOTH AND BROWN-TAIL MOTH.

The State of Massachusetts is spending three hundred thousand dollars per annum to keep in check and prevent the further spread of the Gypsy Moth within its limits, and a large portion of this sum is being devoted to the study of the parasites and natural enemies of both these species; the entire world being ransacked for species that may be expected to give aid in the control of these pests.

The United States Government has appropriated two hundred and fifty thousand dollars for the purpose of limiting the spread of the species within the United States, and this is expended in the New England States of Maine, New Hampshire, Rhode Island, Connecticut and Massachusetts, in all of which the Gypsy Moth has secured a foothold. There is co-operation between the United States and State authorities, and the work in Massachusetts has been divided so as to avoid duplication of labor. An organization has been developed in which over 3,000 men are employed and over 100 power sprayers are in use.

The State of New Jersey is not so far from the nearest point of infestation in Connecticut that it is entitled to sit back and feel safe. The lines of communication between the infested district and our State are direct and I have felt that there was no matter more important in the Entomological line than a close watch on the spread of these two insects. I have, therefore, since the work began, visited the infested districts in Massachusetts at least once annually, so as to keep posted as to just what was being done, and just what might be anticipated in the near future.

During the latter part of September, I spent two days in the vicinity of Boston, extending my excursions as far as Newburyport and visiting also the laboratory at Melrose Highlands. Under the energetic directorship of Mr. A. H. Kirkland, who is in charge of this work for the State, surprisingly good results have been obtained.

So far as the Brown-tail Moth is concerned, attempts to check its spread have been abandoned. The insect flies in both sexes and with a favorable wind may be carried for many miles. Any attempt to limit this species would be foredoomed to failure. It has now covered almost the entire territory between Massachusetts and the northern boundary of the United States, extending also into Canadian territory. It has not yet spread west of Massachusetts, so far as we have any information. It would not be surprising, however, to learn of the presence of isolated colonies, even as far west as the Hudson at almost any time.

This insect is subject to the attack of disease, which in certain seasons reduces it to very small numbers; but it usually recovers after a year or two, and so rapidly does it propagate, that in a single year a forest area may become so badly infested as to be practically denuded of foliage. At the present time certain towns in Massachusetts have square miles of forest in which almost every tip bears a brown-tail nest. So far no effective insect parasite on this species has been developed.

As for the Gypsy Moth, that is another story. The insect

spreads very slowly when left to itself. The female practically does not fly at all. The caterpillars are very active and wander for considerable distances; but their ability in this direction is limited and a natural spread would not be very extensive from year to year. The chief danger with this insect comes from the likelihood of its being carried. The wandering habits of the caterpillars take them away from the trees, even on to passing vehicles, and they may get upon almost any sort of merchandise that is being transported through the infested districts. Egg clusters have been found on freight cars and on material shipped in freight cars. In this way, the insect may make long jumps and has done so in several instances. A tribe of Gypsies shifting their camp from the infested district to one over a hundred miles away, located a colony, which was fortunately discovered before it had spread to any considerable distance.

In the fight against the Gypsy Moth distinct progress has been made and it has been limited in its spread at almost all points. The United States Government has policed several hundred miles of road, and has sprayed the trees for a distance on each side so as to prevent the accidental transfer of the insect in any stage. Badly infested territories have been cleaned, and under the Massachusetts law every municipality is compelled to look after the trees within its jurisdiction, the work being aided by the State appropriation. Fully a million dollars has been spent in the State of Massachusetts during the past year, and to the ordinary observer Gypsy moths at the present time are rather rarely to be found. There are, however, still many points of serious infestation, and all idea of extermination has been abandoned.

In the work of developing natural enemies good progress has been made and under the direction of Dr. L. O. Howard the work done in the laboratory has been as successful as could possibly be expected. We are yet a long way from natural control of the species; but the outlook is more promising than it seemed to be at the beginning, and there is encouragement to believe that ultimate success will be attained. At all events, the result of my trip over the infested territory is that for the present New Jersey is safe from these pests.

ELM LEAF BEETLE.

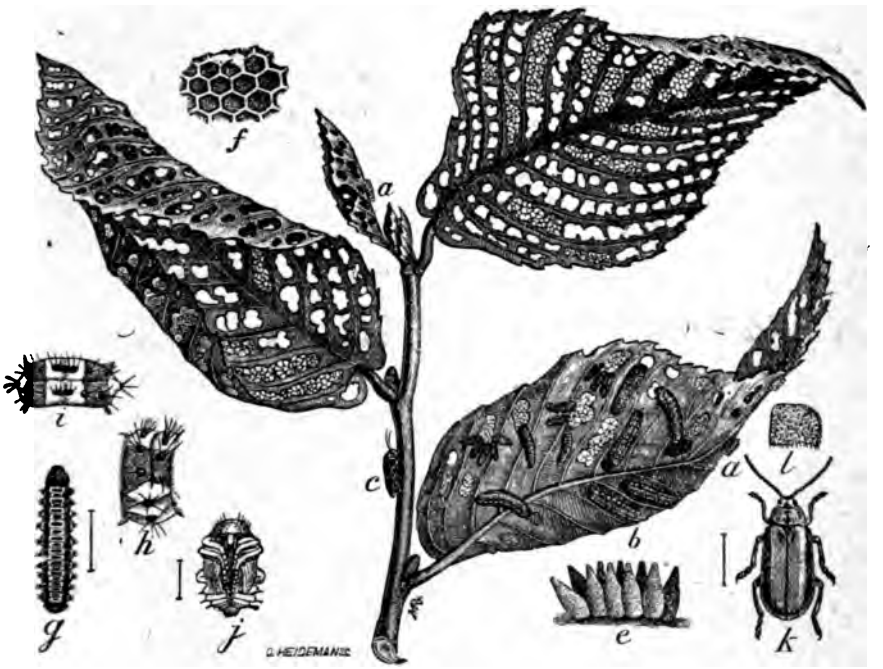

FIGURE 1.

Elm-leaf beetle; *a*, egg patches on leaves; *b*, larvæ feeding; *c*, adult, natural size; *e*, egg-mass; *g*, larva; *j*, pupa; *k*, beetle; enlarged; f, h, i, l, enlarged details. From U. S. Dept. Agriculture.

In the Report for 1907 I wrote, on p. 417, "Not for many years has so heavy a brood matured as reached the adult condition during the season of 1907, and the outlook is for serious trouble in 1908, unless some adverse winter condition reduces the number of hibernating adults." There were no adverse winter conditions and my prediction was miserably correct. Not for a dozen years were the insects so abundant nor was so much injury caused. Not only in cities where the species is always more or less troublesome, but in towns, villages and open country, the elms presented a pitiable spectacle in July and early August.

The heavy rains of May and comparatively high temperature brought the trees into luxuriant foliage early in the season and the beetles, coming gradually out of their hibernating quarters,

attracted little attention and did not seem to be doing much eating. But the egg crop was heavy, and there seemed no end to the additions even after the earliest larvæ made their appearance. Following the rains of May came a drought in June and, shortly after the middle of that month, the full extent of the infestation became manifest. By the first days of July the trees began to brown up, and now inquiries came thick and fast from all parts of the State, from individual owners, from tree commissions, park superintendents and others having to do with the care of trees. The larvæ were then about full grown and coming down the trunks to pupate and thus attracted more attention than ever from those anxious to do something, in revenge for injury done if not in prevention of still further harm.

The advice generally given was that it was too late to spray the trees for the current season; but that the larvæ coming to the ground might be killed with hot water, kerosene, lime or any similar application and many thousands were undoubtedly destroyed in that way, as they lay an inch deep in some places, a distance of a foot or more from the trunk around the base of the tree. But there were other thousands that pupated on the trunk itself, under loose bark scales or in the crevices and depressions of the bark, and these matured and changed to the beetle condition under perfect climatic conditions. I saw no signs of the disease which in some years attacks the transforming larvæ and pupæ and I have never seen, in New Jersey, a larger brood of beetles come to maturity. The same prediction must be made for 1909 that was made for 1908. Unless some adverse winter conditions intervene there will be as much or more trouble in 1909 as there was in 1908.

After the middle of July the drought was broken throughout the greater part of the State and the elms began to revive; those that were worst injured and most nearly defoliated beginning to make a new crop of leaves, just in time to feed the first of the emerging hordes of new beetles all of whom wanted at least one meal before going into winter quarters. Some of these trees were almost completely defoliated a second time and others had the leaves pretty well riddled. By the end of July the beetles had pretty well matured and, while a few of them laid eggs, the great majority made their way into hiding places and now attracted attention indoors; coming in such numbers, that the newspapers were appealed to for information, and fears were expressed that fabrics were in danger.

After the early days of August little was seen of the insects in any stage and the trees, favored by high temperature and plenty

of moisture improved in conditon, and in many cases became clothed anew in bright green. The most favored in this particular were the thin-leaved varieties that had been most injured and had lost most of their leaves. The native, thick-leaved varieties that had held their foliage because it had not been sufficiently scraped to lose all vitality, looked worst late in the season, because many of them put out few or no new leaves.

One point that was referred to in 1907 and again noted in 1908, was that the beetles in the early part of the season seemed comparatively few in number and attracted little attention. Although I knew there was a large brood in hibernation and had notified the janitors, I allowed myself to be put off from day to day by the statement that there were so few beetles about, until the coming of commencement season made spraying inadvisable and matters were left to take their course. The result was that the College elms were quite as bad as any others in New Brunswick, the only applications made being at the base of the trees. The first application was a soluble oil 1 to 10 put on with a sprinkling pot. This proved ineffective because, even though the outer or larval skin was thoroughly wet it did not harm the forming pupa beneath it, and the skin would be normally shed. The next application was of undiluted kerosene put on through a "Friend" nozzle with a Deming pump. This killed a very large number of the larvæ and pupæ; but left plenty of others to come to maturity on the trunks and away from the immediate vicinity of the trees.

SUGGESTIONS FOR 1909.

No one who has elm trees under his care in New Jersey should trust to natural checks to elm leaf beetles in 1909. The brood in hibernation is the heaviest I have known in recent years and, unless some very destructive agency intervenes, there will be specimens enough in the early spring to cause nearly or quite as much harm as in 1908. The chances are all that matters will be worse rather than better.

Elm trees, therefore, should be thoroughly sprayed as soon as the first sign of beetle feeding is seen on the leaves, and arsenate of lead at the rate of 5 pounds in 100 gallons of water should be applied. It is important that this spraying should be prompt and very thorough, the object being to kill off the beetles before they lay eggs. For this reason the strong mixture is advised, that its action may be prompt and the injury to the leaves minimized. All beetles must feed before they lay eggs, and

there is usually a period of about two weeks between the time when the first beetles are seen on the leaves and the time when the first egg mass is noticed. Earlier spraying is not advised because the foliage increases in size so rapidly at this period that leaves sprayed when half grown may be very imperfectly covered a week later when the beetles feed, and the application will not be as effective. Still in cities and towns, or where a large number of trees are to be sprayed, it is better to begin a little early than to delay too long. A good coating of arsenate of lead once dried on the leaves will not wash off no matter how much it rains, so that one application that has had a chance to dry will be sufficient.

Spraying against the adult beetle rather than its larva is further urged because the beetle eats the entire leaf tissue and therefore gets the poison whether it is on the upper or under surface. The larva eats only the cells of the underside and scrapes to the middle only. In consequence any leaf not covered on the underside may mature a dozen larvæ unharmed, even though the upper surface may be uniformly and effectively coated. When we have large trees to deal with the problem of hitting the underside of every leaf becomes an almost impossible one to solve, while merely covering every leaf on one side or the other is a comparatively simple matter.

It means being absolutely ready to go to work as soon as the elms begin to leaf out, and it means that when once begun the work must be carried to a conclusion as rapidly as possible. A period of ten days, possibly two weeks exists for the most effective work, and that should be put in on the largest and most difficult trees. Small trees that can be easily reached so as to hit the underside of the leaves may be left until the larvæ appear, if necessary; but no elm tree that is of any account at all should be left unsprayed in 1909.

EGG-PARASITE OF ELM-LEAF BEETLE.

During the current season Dr. L. O. Howard, Entomologist to the United States Department of Agriculture, obtained from Montpellier a shipment of a minute parasitic wasp, *Tetrastichus xanthomelænæ*, which seems to be very effective in keeping down this shade-tree pest in the vicinity of Paris and other portions of France. The habits of this little wasp which attacks and developes in the eggs of the beetle were observed and published by Dr. Paul Marchal at Paris, and Dr. Howard believed that, could the insect be acclimated in the United States it would probably do equally good work here.

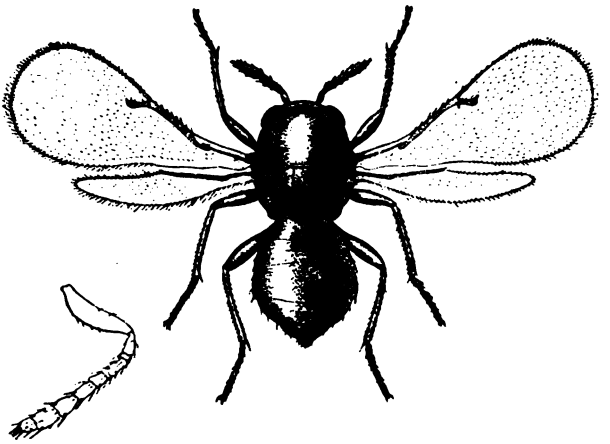

FIGURE 2.

Parasite on eggs of elm-leaf beetle: *Tetrastichus xanthomelænæ* Rond. From Journ. Econ. Ent.

A shipment of infested beetle eggs was received at Washington May 28th, and transferred to Boston, to the care of Mr. W. F. Fiske, in charge of certain parts of the parasite experiments against the Gypsy Moth, on June 1st. On that date Mr. Fiske found the parasites present and active and at once provided them under proper conditions with egg-infested elm leaves; the beetle being then very plentiful in the vicinity and actively ovipositing.

An account of what was accomplished in the way of breeding these insects is published by Dr. Howard in the Journal of Economic Entomology for October, 1908, and it appears that several hundred specimens were bred and liberated near Melrose Heights, Mass., and that they spread for some distance from the point of introduction. When it became apparent that specimens were to be obtained in some number, Dr. Howard was good enough to instruct Mr. Fiske to send a little lot of them into New Jersey, which was accordingly done so that the specimens reached me on July 22nd. At this time the beetles were maturing in large numbers at New Brunswick and there were any quantity

of larvæ and pupæ present; but nowhere, on the 22nd or 23rd could I find any egg masses. The specimens came in rather a large bottle containing elm leaves on which were egg masses: some apparently sound, others apparently parasitized and a few just hatched, with recently developed larvæ near by. There were also a number of the very active little parasites which I was compelled to leave in their confined quarters until the 24th, when I succeeded in finding a few egg masses on a small elm near one of the College buildings. On this I liberated the insects very carefully, taking out leaf for leaf and fastening it to some sheltered point and, when I observed one of the insects making its way to the mouth of the bottle, I held this so that it found footing on a twig or branch. There were only a few of the active insects and none had died in the bottle. Judging from the color of some of the unhatched eggs there were some parasites yet to be developed.

Nothing was seen of them later; but that is not surprising because there were few egg masses on the tree; but no larvæ were later seen feeding on the foliage.

The introduction at this season may not prove effective. There is no second brood of the elm-leaf beetle at New Brunswick though, usually, a very few of the summer beetles lay eggs, and some larvæ may be found on the newer foliage in August. There are other, larger elms close by the little one where the parasites were liberated and, if the latter have any traveling ability, they probably succeeded in finding food enough to maintain themselves; but probably no more.

As, however, the insect was also started at Washington, where there is a well developed second brood of beetles, and over 1,000 specimens were liberated at Melrose Heights in July, while there was an abundance of eggs present, there is every probability that the species will maintain itself during the winter. It will be my effort to secure, early in 1909, a sufficient number of parasitized eggs from one or the other of the localities mentioned, to make certain of establishing the species in New Jersey.

WHITE MARKED TUSSOCK MOTH.

This species was unusually abundant on the shade trees in cities and towns in the eastern part of the State; but very little trouble was experienced in the western section where, in some previous years, it has been very abundant. The insect is a general feeder and supplemented the work of the elm-leaf beetle by attacking other trees, so that there was a uniform condition of

ragged foliage, or no foliage at all throughout a large part of some of the infested cities.

The various shade tree commissions did exceedingly good work under adverse conditions, and in Newark especially, all sorts of devices were introduced to interest the general public and to secure the destruction of caterpillars and egg masses. For a time egg masses were purchased at a fixed price per quart, delivered at certain points in the City, and a very large number of eggs was disposed of in this way. In spite of all that was accomplished the trees suffered markedly; but conditions were so much better than they would have been under other circumstances, that full value was received for all the expenditures made. It is unfortunate that a sufficient amount is not available to once clean the city districts thoroughly of this insect. It is not easily spread, and if once thoroughly under control it could be kept so for the future with little difficulty.

There is little hope to be expected from natural enemies. At the laboratory we had a large number of pupæ gathered from the trees in Newark, and out of these we bred a considerable number of hymenopterous parasites; but altogether too few, proportionately, to have any serious effect upon the insects. The sparrows will not touch the caterpillars and rarely touch the female moths.

Mr. Henry Herpers, of Newark, suggests that there has been a loss of vigor during the present year, and that the egg masses are materially smaller than they were during the season of 1907. He counted a large number of them and found that this decrease in the number of eggs is quite general. Mr. Herpers also succeeded in breeding from the eggs a number of specimens of a parasite which seems not common under ordinary circumstances. None of them were observed in the material that we had in the laboratory, and it seems to be very little referred to in literature. City conditions favor these insects very greatly while their natural enemies, which prevent any increase in the forest, are unable to maintain themselves as well as do their hosts.

THE WOOD LEOPARD MOTH.

This insect has been less troublesome in the large cities during the last year or two than it was several years ago, and there seem to be a number of reasons for this. First, the destruction of the adults at the electric lights was really enormous: second, the greater appreciation of the value of trees resulting in the establishment of Shade Tree Commissions, has resulted also in greater care on the part of tree owners. Obviously infested branches

have been trimmed out, and branches broken off by the wind have been gathered and burnt, so that many larvæ have been destroyed. The systematic work of the Commission in Newark, for instance, gives the species very little opportunity, and the adults instead of being common everywhere at the electric lights on the streets, are now extremely rare.

On the other hand, the species is extending its range. During the last two years it has travelled along the coast and during the past summer has been noticed at South River near New Brunswick and as far south as Long Branch.

Early in the year inquiry was made by an owner of a fine Maple grove near Maurer, in Middlesex County, and it turned out that the borers had found lodgement in his trees in considerable numbers. Cutting out was advised so far as that was possible and the establishment of arc lights in the grove to attract the adults. Nowhere along the line of distribution has the insect been seriously troublesome except in this Maple grove, and I have always attributed this slow spread and lack of injurious effect to the work of our native birds. It is possible that they may require a year or two to become familiar with the borer and that may account for the trouble. The species is so very prolific that even a few females could produce larvæ enough to do decided mischief in a limited number of trees.

A very interesting fact which has come to light during the present season is that the insect has made quite a jump northward and eastward and has established itself in the City of Boston and vicinity. Mr. A. H. Kirkland, Superintendent of the Gypsy Moth work in Massachusetts called attention to this occurrence in a newspaper publication in 1907; but the facts did not become generally known. Just how the long jump was made is yet a question; but as there is direct railroad and ship communication between New York and Boston, and the transfer could have been made through infested wood either summer or winter, it is not difficult of explanation. Dr. Britton of the Connecticut Experiment Station says the insect has also been found in his State; but as yet in isolated examples only.

CATALPA SPHINX.

For several years past I have been recording in these reports the gradual spread of this species throughout the State. It was especially during the nursery inspection work that it was met with, and in some cases active work on the part of the nurseryman was required to prevent serious injury to the young trees.

Shade trees in all sections were also attacked and, at last reports, practically the entire State had been covered.

For the last year or two it had been noticed that parasitism had increased very materially and that, or some climatic condition which was not appreciated, has resulted in the almost complete elimination of this species during the past summer. The nurserymen in almost every case remarked on the absence of the insect, and spoke of it as having been either entirely wanting or present only in very small numbers. In only one instance did the insect appear in such form as to make spraying seem desirable, and even then it was done more as a matter of precaution than of immediate necessity.

The general collectors noted the same thing and Mr. H. H. Brehme, who has made rather a speciality of hunting caterpillars of this family, reports the almost entire absence of the species in 1908, after a season of severe parasitism in 1907. He feels inclined to charge the rarity at this time entirely to the action of parasites. It is not at all improbable that the natural enemies of this species may secure such control of it in New Jersey, which is outside of its normal range, that it may not for many years reappear as a troublesome form.

THE SNOW WHITE EUGONIA.

On the evening of July 17th, Newark, Elizabeth, Paterson, Jersey City and some of the surrounding towns were treated to a unique experience; a veritable swarm of snow-white moths flying around the electric lights and giving the appearance of a snow storm in mid-summer! On the evening of the 16th, the same sort of appearance occurred in New York City, attracted much attention and was widely commented upon in the newspapers. Just how far this swarm extended in New Jersey has been impossible to ascertain; but certainly to all the cities and towns in Hudson and Essex Counties and probably for some distance along the Hudson River. This flight was composed of individuals of the Snow-white Eugonia, known everywhere half a century ago as the parent of the "span worm." It was at that time the most abundant and destructive shade tree insect in the Eastern United States, and its caterpillars, feeding upon most of the shade trees, were a nuisance by their habit of suspending themselves by threads from the foliage upon which they fed and dropping upon pedestrians moving beneath.

These caterpillars were responsible for the introduction of the English sparrow into this country. So abundant were they and

so helpless were the authorities against them that the suggestion was made and favorably acted upon, that this foreign bird be introduced for the specific purpose of dealing with the "worms." The sparrows did their work well. It was not long before the caterpillars practically disappeared from the cities, to be replaced gradually and effectively by the hairy caterpillars of the tussock moth, which the sparrows will not touch.

It is remarkable that after several decades this insect should appear again for a day or two in its old time abundance. In my experience of over twenty years I have never known a flight of this kind, nor have I seen the insect at all common.

As it happened I was at Lyons Farms on the evening of the 17th, and about 10.30 was on the platform of the railroad station at Elizabeth, where the insects were flying in some numbers around the electric lights; but by no means as abundantly as they were at Newark and in some other places. At New Brunswick, Mr. Grossbeck found only a single specimen, and there was no record of any flight.

Another remarkable feature was that the caterpillar was absolutely unnoticed despite the fact that it must have been present in countless thousands on the shade trees. It may be that the abundance of elm-leaf beetles and tussock moths obscured the work of this species, so that it was not noticed as it would otherwise have been.

A few days later, on the evening of July 23rd, an exactly similar occurrence was recorded from Ottawa, Ontario, Canada. There must have been, therefore, some uniform condition that favored the development of this insect and kept down its natural enemies. It is not at all likely that anything like this will occur again for some years to come.

On the morning after the flight the sparrows apparently became very busy soon after day-light, and all that was left to mark it was enormous quantities of wings without bodies.

BLACK PEACH-APHIS.

Peach trees have suffered seriously during the season from a variety of causes, and young orchards especially, have lost an unusually large percentage of trees. This was charged to all sorts of things, but most frequently, in the cases brought to my attention, to the effects of the spray materials used. Every case of this kind was investigated when reported, that the effects of the various materials could be determined, and in no case could the dead trees be fairly charged to the insecticide employed.

Black Peach Aphis as it Appears on Roots of Young Peach Tree: Original.

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Fig. 3. Black Peach Aphis as it Appears on Roots of Young Peach Tree: *Original.*

First, the winter was unusually hard on young trees, especially on undrained or wet land and in the majority of cases examined by Mr. Dickerson and myself the dead or dying trees were in either a depression or in a basin in which water lodged. Mr. Blake reported similar conditions, and it was he who first called my attention to the prevalence of the black aphis on the roots in the more southern sections of the State, assigning this as one of the reasons for the poor condition of many trees. I was able to verify this later, and found throughout South Jersey an abnormal development of this root-louse; especially in the lightest, sandiest soils. It was also noted that where the trees were best looked after and fed, the injury was least noticeable, and that furnishes an indication for treatment.

This black aphis is often found in small numbers on nursery trees, especially those grown in the south, on light soils. Proper fumigation will kill these lice; but growers generally object to fumigated trees and nurserymen will not, as a rule, fumigate unless they must. When such infested trees are set out in light land the lice multiply and feed on the small rootlets near the trunk, working outward later as they increase in number. Little trouble is noted during the first season as a rule; but during the early part of the second year the insects become plentiful enough to attract attention. They become noticeable on the leaves of the plants in June and are sometimes plentiful enough at that time to cause quite a bunching and crippling of terminal shoots. Except in this position they are rarely seen by the fruit grower, who will not ordinarily suspect root insects when the trees begin to turn yellow and look sickly about midsummer.

In dealing with these insects prevention is better than cure. No trees should be set without being carefully examined for root lice and, if any are noticed, the roots should be dipped into a strong tobacco decoction and thoroughly wet. Or they may be dipped into clean water so as to wet thoroughly, then dipped into a pail of tobacco dust so as to powder them thoroughly, and a handful of the dust or ground tobacco should be thrown around the roots before the soil is drawn upon them and pressed down. Nothing is better and safer than tobacco for this purpose, and if this practice is carried out there will be little plant louse left to make trouble.

If this precaution has not been taken and injury developes, the tree should be stimulated by appropriate fertilizers, and there should be, in addition, a liberal application of tobacco dust or ground tobacco in a basin around the trunk of the tree, the dust

to be covered over with soil to prevent its being blown away or otherwise disturbed. A decoction may be used instead of the dust, but there should be at least a gallon to a tree if older than 2 years, and the basin should be deep enough to reach the surface roots.

As the insects do not usually get very far away from the trunk on young trees, the outer circle of the basin need not be much over 18 inches in diameter. The tobacco is in itself a fertilizer and worth almost as much as it costs, as such, so its use secures a double effect. When a tree is once fully established and has reached the bearing age it rarely suffers if it is reasonably well fed and otherwise cared for.

If a tree is killed by these insects, another one should not be set into its place without having a liberal amount of ground tobacco mixed with the soil packed around it.

PEAR PSYLLA.

This insect has always been locally troublesome in New Jersey, some few orchards being much infested, while others around them were practically free. And it is not by any means the poorest orchards that are troubled; but rather the better or even the best in the vicinity. Nor is the insect more likely to be in one section of the State than another, although during the two or three years last past it has been more common in the southern parts, chiefly because most of the pear orchards are there.

Two large orchards, one near Glassboro in Gloucester County, the other near Riverton, in Burlington County, suffered severely in 1907, and were treated during the winter or early spring. The Gloucester County orchard was thoroughly sprayed in winter with undiluted crude petroleum, the effort being to force the oil in a fine spray into every bark crevice on the trunks. The effect was seen in late August when only occasional specimens of the *Psylla* were encountered on the trees and absolutely no injury was caused.

In the Burlington County orchard the trees were scraped early in March to get rid of as many specimens as possible and to expose the others on the trunk. The intention had been to burn the scrapings or to bury them in a plowed furrow; but neither was done in time. The scraped trunks were then painted and sprayed with crude petroleum and the effect was also good, although there were more specimens than in the Gloucester County orchard. When an examination was made in late June adult *Psylla* were found not at all rarely and in a few places some

twigs showed evidence of honey-dew. But they did not become numerous enough later to do any notable injury. This experience accords with previous work done in Cumberland County and there seems to be little doubt but that we can control the insect by winter or early spring work. On old or rough-barked trees scraping off the loose scales in winter and burning the scrapings will be very useful as a large number of the dormant specimens will be thus disposed of. The scrapings should not be allowed to lie in the orchard, for if the insects warm up under a bright sun they may become sufficiently active to move off and seek other shelter.

The tree trunk should be very thoroughly treated with crude oil, kerosene, or one of the soluble oils, applying with force enough to get the material into every crevice and under every bit of loose or projecting bark. They are not so difficult to kill when once the material reaches them; but in seeking winter quarters they get just as far into shelter as they possibly can, and will not be affected by superficial work or any material not capable of penetrating into narrow crevices.

GRAPE PLUME MOTHS.

An unusual number of complaints was received of supposed injury from this insect. It came largely from owners of village and town gardens and indicated that much more attention was being paid to such plants now, than in the past and that owners were anxious to be informed. As a matter of fact this insect does practically no harm. The whitish hairy little caterpillars spin up the tips of the shoots after they have made a good start and usually stop the growth; but the check is almost always given beyond the point where the blossom cluster forms and a new start is usually made from the side of the tipped shoot, carrying the fruit to maturity. No practical means of reaching these little caterpillars with sprays have yet been devised and in the vinyard the matter has not been considered of sufficient importance to warrant experiment. In the garden where only a few vines are to be looked after, the caterpillars in the infested shoots can be readily killed by a little pressure on the webbed up tip. If this s done early, the growing shoot will tear apart the silken threads nd will go ahead without material stoppage.

THE ROSE CHAFER.

This insect while not quite so abundant as in the year or two t past, nevertheless was very troublesome locally, in Salem and

Cumberland Counties. In Salem County the trouble was largely confined to recently cleared scrub-land and the areas adjacent to them. In Cumberland County some of the localities near Vineland, where this insect has always been harmful whenever it occurred at all, have had considerable swarms to deal with. Here too it was the vinyards that were nearest to uncultivated or sod land that were most injured, and in some large grape areas only the outer rows became at all badly infested. It is probable that in such cases strong mixtures of arsenate of lead, say 1 pound in 5 gallons of water would act promptly enough to protect the major part of the vinyard. No direct experiments were made to test this point; but incidental observations make this seem probable and the matter will be fully tested next year.

The only new material tried was a preparation of Picric acid which seemed to offer some chance of good result. The experiments were made at Vineland and will be found recorded under the Insecticide heading in this report. It is sufficient to say here that the results were disappointing.

STRAWBERRY LEAF ROLLER.

This insect has become increasingly abundant in localities where in previous years it was not known as troublesome. In parts of Atlantic and Cumberland Counties it has done much injury and in Atlantic County it has caused, at times, serious loss. It is in Burlington County that it now shows itself in such numbers that growers fear danger.

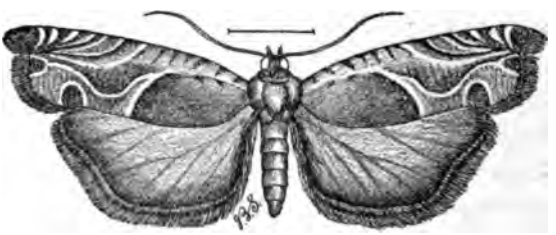


FIGURE 4.
Parent moth of the strawberry leaf roller.

With a knowledge of its habits there is no reason why there should be any great difficulty in controlling it. The little moths appear in the field about the 1st of May, and are readily recognizable by their rusty brown color. They lay their eggs on

the under surface of the leaf and the little caterpillar, when it hatches goes to the upper surface, folds this leaf, holds it together with silken threads, and thereafter feeds in the shelter of this fold safe from any poisonous applications afterward made. The entire secret of success in dealing with this insect is in getting the foliage covered with an arsenical poison *before* the young caterpillars have a chance to secure shelter, and for this purpose nothing compares with arsenate of lead. This should be applied at the rate of 1 pound in 20 gallons of water not later than May 10th, and should be put on with force enough to thoroughly cover the upper surface of every developed leaf. Ten days later a second application may be advisable if moths are seen in abundance; but otherwise 1 application thoroughly made will be sufficient. A knapsack sprayer with a spray rod that reaches close to the plants and a medium Vermorel nozzle are best for this work.

THE STRAWBERRY WEEVIL.

This well known pest has been increasingly abundant in parts of Atlantic County during the two or three years last past, and a series of observations was made near Egg Harbor City between May 9th and July 11th, covering the entire breeding season of the insect, in the hope that some practical method of control might be suggested.

May 9th found the adult beetles already present in the field in considerable numbers and that they had made their appearance with the earliest strawberry blossoms. Already there were drooping and fallen buds so that there must have been at least two weeks during which the insects had been in the field. In this locality no effort is made to get very early varieties, as these would come into market with southern berries and take the low prices which these bring at the end of their season. The effort is rather to get fruit in time to follow the southern supply and get the best prices for fine mid-season berries. The Fairdale Giant is the earliest variety grown here, followed by the Gandy which is perhaps the leading form, and then by the Stevens Champion which is an inferior berry but a good shipper and usually profitable.

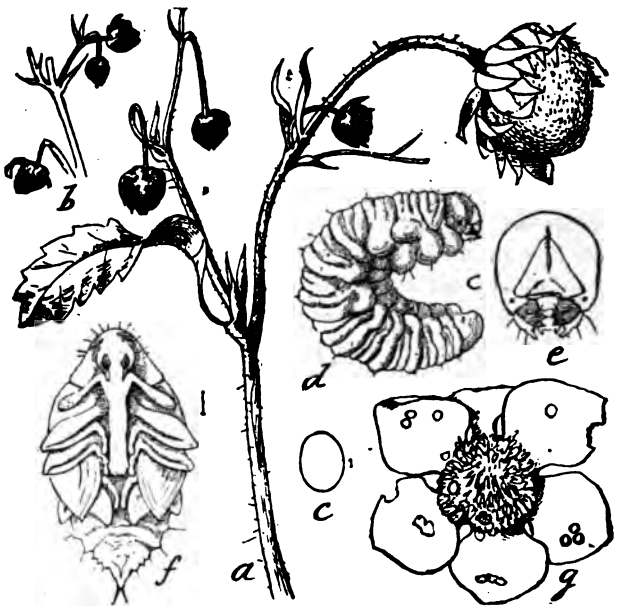


FIGURE 5.

Work of strawberry weevil; *a*, spray with punctured buds; *b*, wilting buds; c, egg; d, larva; f, pupa; all three enlarged; g, flower with feeding punctures. From U. S. Dept. of Agric.

In the fields visited it was observed that the older patches were worst infested and that where a field bordered a piece of woodland the marginal rows were much worse than any others; in some cases more than half the buds being cut. This is not surprising, because the adult beetles hibernate in such places under rubbish and in any sort of shelter that they can find.

The actual damage is not really measured by the percentage of buds destroyed, because these are the earliest, that would ordinarily have been made the finest berries and brought the highest price. Examined in the laboratory, eggs were found in most of the buds, but no larvæ had yet hatched. The injury caused is due to the feeding habit of the larva which requires pollen for its development. The female beetle, therefore, lays its rather large, white, glistening egg into a well developed bud of a staminate variety and, in order to prevent further development, punctures the flower stalk just below it. In a day or two the bud wilts, the stalk breaks at the point of puncture, and usually the bud drops to the ground, although it may hang on for some days by a few

threads of tissue. This dropping to the ground favors the development of the larva which, exposed to the hot sun, might otherwise dry up, or the bud itself might become too hard and unfit for food.

May 16th, Mr. Dickerson was sent over the same ground and found the beetles still at work, although less abundant. The Fairdale Giants seemed to be no longer attractive, the Gandys were yet well infested, but the height of the danger period seemed to be over and a fair set of fruit was on the plants.

In a neighboring dewberry patch in which there had been some injury in 1907, the flower buds were still undeveloped, none of them showing white; but already the beetles were present and some buds were already cut. The insects were evidently coming on here from an old Gandy bed which had bloomed early and had been very badly cut; but was now beyond the attractive stage. Beetles were also noticed on the wild strawberry, *Fragaria virginiana;* but at this time no cut buds were seen.

May 26th, there were cut buds on these wild plants as well, and also on a species of blackberry. In the strawberry fields very few beetles could be found, nor did many infested buds remain attached to the vines: almost everything was on the ground. From this time on the strawberry plants were safe, and on the dewberry plants also the injury seemed to be completed. The total amount of cut buds on these was small compared to those on the strawberry and apparently only the tail end of the brood was placed here.

An examination of the collected buds at this time showed all stages from egg to pupa, and the first adults were obtained June 1st. On the 4th of that month 45 beetles emerged and this may be considered as about the date when development became general from strawberry buds. In their early stages the larvæ feed on pollen only; as they increase in size the harder parts of the buds are attacked, and the full-grown larva eats out a sort of cell at the base of the bud in which it pupates: the entire period from egg to imago requiring a little less than a month.

June 15th, cut buds were found still attached to the dewberry plants, mostly with half-grown larvæ; but no weevils were present. The dewberry flower stalks are much stouter than those of the strawberry and broke much less readily; while the remaining tissue maintained enough life in the bud to keep it in suitable condition for the insect development. On this date the running swamp blackberry, *Rubus hispidus,* was just coming into bloom and some of the buds here had also been cut. Weevils were found

in small numbers and some of these were, apparently, still ovipositing

June 23rd, few recently cut buds could be found, but adult beetles were observed feeding in the flowers of the blackberry and also in chestnut bloom. In the laboratory beetles began emerging from blackberry, *R. hispidus,* buds June 27th, and continued to emerge until July 2nd.

July 11th, the area was visited for the last time during the season and no trace of adults could be observed. They had evidently sought winter quarters thus early, feeding only a very little before seeking shelter.

LIFE HISTORY.

From the above record it appears that the beetles hibernate in rubbish, and under leaves, preferably in woodland, and become active early in April. The females begin to lay their eggs as soon as they can find buds in suitable condition and the earliest of these are on the cultivated strawberry. They continue, feeding and laying eggs until after the middle of June, taking in succession after the strawberry, dewberry, wild strawberry and blackberry. Development from egg to adult requires about one month, the earliest adults appearing about June 1st and continuing to appear until about July 5th, these adults feeding little and disappearing into hibernating quarters shortly thereafter.

REMEDIAL MEASURES.

There is no period in the life of this insect when it can be satisfactorily reached by insecticides. The adult feeds little, usually on pollen or by eating holes into the well developed blossom buds. Whether the insect devours the tissue when it cuts through the flower stalk is not known. The larva feeds in shelter continuously and is entirely beyond our reach.

As the larva feeds only on pollen, pistillate plants which bear none are free from attack and the obvious recommendation is to plant pistillate varieties with every third or fourth row of some profusely flowering staminate variety to serve as pollenizers and to attract the insects. This method has been actually adopted in some of the Southern States with good effect. The objection is made that there is no known pistillate variety which does well in New Jersey and fulfills the requirements as to time of ripening, shipping quality, etc. That there is no fruit so erratic in its

action in different localities as the strawberry is well known, and I have not found any plant grower willing to recommend any variety that would probably fill the bill.

The next method is to plant very profusely flowering varieties with the idea of getting buds enough to keep the beetles and to make a crop as well, and both the Gandy and the Fairdale Giant fulfill these requirements to a considerable extent although the percentage of loss is too great to leave a satisfactory margin of profit for the grower. Added to the above we might suggest some very early profusely flowering variety to be set in a row or two along the probable sources of supply: i. e., woodland or brushy road, to serve as an attraction for the beetles and keep them from the main crop. This would mean, of course, planting for the beetles only, and the trap row might afterward be cut close, the foliage, etc., carefully raked up and burnt and then the ground sprayed with a miscible oil or kerosene emulsion 1 to 10 to soak the cut buds and kill the contained larvæ.

Covering the rows with cotton, muslin or similar material has been recommended and, on a small scale, has been found successful. It not only keeps off the beetles but promotes earliness and extra fine fruit. How it would work on a commercial scale has not yet been determined.

While, theoretically, spraying with arsenites does not seem to offer the slightest prospect of success, it has nevertheless been asserted that applying Paris green with bordeaux mixture three times, once as soon as the earliest buds are well formed, a second time when the plants begin to bloom and a third time ten days thereafter, will serve as a protection. This may be less by its direct effect upon the insect than by making the plants objectionable to them, and is worth trying. Arsenate of lead, 1 pound in 10 gallons of water or bordeaux mixture, may be used instead of the Paris green.

Finally I would recommend that, in localities where this beetle occurs in troublesome numbers, strawberry beds be placed so far as possible in the open, well away from wood or scrub-land or overgrown road or fences, and that the ground and its surroundings be kept as free as possible until after mid-summer, so as not to supply hiding places in which the adult may winter.

CUT WORMS.

These pests were even more than usually in evidence during the early part of the season and caused injury to crops not usually troubled by them. Under another heading the injury caused on

cranberry bogs is referred to at some length, and Mr. M. A. Blake, our horticulturist, noted them as being very destructive on lima beans planted after a crimson clover sod: entire plantings being completely cut down. In the gardens and on the usual field crops injured by them, they were present everywhere; but were not abnormally destructive. Arsenic either as a spray or mixed with bran as a bait was successfully used in many cases, and furnishes a complete preventive of injury when intelligently used.

CABBAGE WORMS.

Cabbage worms have been extremely abundant, especially in the more southern sections of the State. Late in July and in early August requests came for information as to the best methods of dealing with the insects, and the work of the caterpillars was obvious from car windows in riding through the country. Arsenites were uniformly recommended, and generally the arsenate of lead was suggested as preferable, from its sticking qualities.

The caterpillars in fault were mostly those of the common white butterfly, which was conspicuously numerous late in the season; but the semi-looping *Plusia* was also in evidence and did its share of the work. Indeed it was more obvious than the other, because of its habit of boring into the head and because of the conspicuous masses of yellowish excrement which were left on the outside of the head.

In treating cabbages careful work is required to get the poison to stick. Careless applications of coarse sprays, applied with little force, are bound to be more or less unsatisfactory. It may be repeated that there is absolutely no danger of poisoning from sprayed cabbages; but the outer leaves and stumps must not be fed to stock, because these outer leaves get most of the application while nothing gets into the head.

TOMATO WORMS.

Not for many years have there been so many complaints, principally from the more southern counties, of the abundance of "horn worms" on tomatoes. These caterpillars are the early stage of one of our largest hawk moths, often seen in the early evening flying about the flowers of honeysuckle, petunia or even the jimpson weed. Large as these caterpillars are and voraciously as they feed they are not often noticed until they have

attained a considerable size, and even then it requires a little practice to recognize them on the tomato vines.

It was in general recommended that hand picking be resorted to. The caterpillars are really not very numerous and destruction by hand is positive and stops mischief at once. Growers were also advised that if the tomato fruit was not yet well advanced and would not be ready for use for at least two weeks thereafter, that they might spray with Arsenate of Lead at the rate of one pound in twenty gallons of water. There is no danger in making an application of this strength, so long before the fruits are used; but growers were cautioned not to make any such applications on vines from which picking was done.

Many people hesitate about handling these caterpillars because of the formidable looking horn at the end of the body; but this is really entirely harmless and there is nothing about them that would injure even the most delicate skin.

CORN WORM.

This species was plentiful throughout the State and was made the subject of complaint quite frequently during the early sweet corn season. It was even more harmful than most growers realized, because the early brood got into the embryo ears and destroyed them before they became outwardly visible at all. Quite a number of growers remarked on the number of barren stalks in their field; but the causes assigned for this condition were generally anything but this obscure insect attack of which there was little outward sign. The late sweet and field corn was less troubled because there was an abundance of more easily accessible food when their period came along. It was the earliest ears that suffered most and, of course, the farmers loss was in the early crop.

The question is constantly asked whether it is not possible to protect by spraying with some arsenite; but the habits of the insect make this impossible. Late fall plowing of infested cornfields is yet the only feasible method of control and that acts on the crop for the year to come. The date of plowing may be any time after the corn is harvested and has thoroughly dried, and there is no reason why a cover crop should not be sown after plowing and harrowing, to protect the surface.

ONION THRIPS.

Hot dry weather always favors *Thrips* development and the weather during June, July and a large part of August was ideal

for the insects. Mr. Dickerson therefore noted incidentally, during his maggot investigations, that about mid-summer the onion leaves began to show the characteristic yellow spots, and that there seemed a very decided check to growth in consequence. About the middle of July, great numbers of specimens, mostly immature, were observed in a number of fields, and the distribution seemed to be general, from Cape May to Monmouth County, although not uniform throughout the region. I noted the species also in Connecticut, although not so injurious as in New Jersey. The combined effects of Thrips and drought were to reduce the crop by fully one-third in some fields. Unfortunately there is no practical remedial measure. Plenty of cold water is all that is needed, really; but that is not always available in a season like that of 1908. Whale oil soap suds at the rate of 1 pound in 4 gallons of water would probably answer also, especially against the immature forms.

POTATO FLEAS.

Under this term two quite diverse species became subjects for complaint; the well known flea beetle, eating characteristic little round holes in the tissue, and a species of leaf hopper which, in conjunction with the dry weather, caused a burning or browning effect on the foliage.

It was very difficult this season, to determine just how much injury on potato vines was caused by insect attack. About midsummer most of the fields in many sections turned brown as if a fire had been sent over them. At first much of this trouble was charged to insects and, as a matter of fact, fields in which the plants were much peppered by flea-beetles were the first to show the browning. And so too, in some of the fields first examined, leaf hoppers were found present in quantity. But after a few days more there was no difference in favor of otherwise uninfested fields, and practically no harm could be charged against the insects alone.

Incidentally, it may be said that fields carefully sprayed showed better than those left untreated, although they also suffered.

PLANT BUGS.

During the first half of July there came complaints of some insects stinging the shoots of a variety of plants, from potatoes in the field to Dahlias in the garden, the punctured shoots dying as the result of the sting as tho poisoned. Investigation showed that in each case the species at fault was one of the smaller, soft

plant-bugs, *Poeciloscytus basalis* which was present in great numbers on many kinds of foliage, especially in gardens. Of these Capsids there are many species, quite similar in general habits and closely allied. As a rule they are general feeders, puncturing leaves and stems to secure the plant juices on which they feed. It is not often that they attack field or cultivated crops; but during the past season this particular species did appear in harmful numbers and killed a large number of growing shoots by its feeding. At the point where they punctured the tissue a brown spot appeared soon afterward, and this extended until the shoot beyond it began to wilt and finally died. It seems that in feeding some of the salivary secretion was injected into the cells, and this did really poison and kill them. The application of kerosene emulsion was advised; but the period during which the insects remained proved to be very short and, by the end of July they had disappeared.

INSECTS ON CUCURBS.

There is always more or less trouble from the striped cucumber beetle, and no ordinary visitations are complained of. But some of the visitations in 1908 were decidedly beyond the ordinary and, combined with the droughty conditions, caused unusual injury in some localities. Lime and tobacco dust were the remedies recommended and usually applied, a little turpentine or carbolic acid being sometimes added to the lime to increase its repelling powers. The injury is done by the adult beetles almost entirely. By the time the larvæ appear the vines are sufficiently well grown to stand the feeding that is done by them.

Melon lice were troublesome in a few places, for a short time only. Their natural checks were abundant and the aphid was very soon under control. In only a few cases were destructive measures resorted to.

Squash borers were more than usually numerous in some localities and here too the dry weather intensified the injury and made it impossible for vines to recover, where in ordinary seasons they would have rooted at the joints and managed to carry their crop to maturity. It was on the lightest soils that most harm was done and that, of course, was easily explained by the weather conditions already referred to.

ASPARAGUS BEETLES.

These have been unusually abundant during the summer and almost from the opening of the season reports of injury were

received. It was the old species, *C. asparagi* that was generally noted, only a few specimens of the 12-spotted form being received. Apparently the winter conditions were favorable to the hibernating adults, and they made their appearance in force as soon as the sprouts showed above the surface. Growers who were familiar with the insect at once permitted some of the poorer shoots to grow, and these proved more attractive than the undeveloped heads. Unfortunately the matter was not followed up in most cases by cutting and destroying the trap shoots as soon as they became covered with eggs and, in consequence, there was a very heavy brood of larvæ which very seriously injured the plants in many fields. Combined with the effects of the rust, this feeding produced a decidedly disreputable lot of asparagus fields in most sections of the State. There was not much complaint of trouble in young fields, and the infestation on such places seemed to be very slight.

DIGGER WASPS VERSUS CIDADA.

A peculiarly interesting feature of the year has been the increase of the large, Cicada-feeding digger-wasp, *Sphecius speciosus*. This is the largest wasp that we have in New Jersey, and

FIGURE 6.

Digger wasp carrying a Cicada to its burrow. From U. S. Dept. of Agriculture.

during the five or six years last past it has become increasingly abundant, making its colonies in open, bare or sparsely covered ground. The females dig holes which go down vertically for a

short distance, and then run a longitudinal gallery with cells or pockets opening from the sides. In these cells they store the Cicadas on which the larvæ feed, sometimes two or three in one cell. The wasps capture and sting the Cicadas so as to paralyze, while yet retaining sufficient vitality to protect them from decay. So abundant did they become in some places, that they got to be a good deal of a nuisance, especially as they look rather formidable and certainly do have a long and vicious sting. But they are not really aggressive and do not sting unless directly interfered with.

At New Brunswick they were so numerous in 1908 that they practically exterminated the Cicadas in that part of the City in which I live. In former years the singing of these Harvest flies on the trees of the College Campus and the adjacent avenues was quite a feature, and specimens were frequently captured. This year the songs were brief and not a single specimen was taken. As the Cicadas are not really harmful to the trees and their "singing" is a characteristic summer sound, the disappearance is rather to be regretted. It will be interesting to note what effect this lessening of its prey will have upon the wasp.

CHINESE MANTIDS.

Heretofore the records concerning the introduction of this species into New Jersey have been distinctly discouraging and even yet there is nowhere in the more northern portions of the State any well established colony. There is reason to believe, however, that the species is maintaining itself at almost every point where it was colonized altho in most places that is about all that can be said of it. At New Brunswick I find an egg mass or two in my garden each year. In Burlington County at least two colonies have maintained themselves so that specimens are noticed each year and there is one colony in Atlantic County.

At Anglesea, Cape May County, Mr. Philip Laurent from whom I obtained all of my egg supply, himself put out egg-masses in considerable number for several years, and there is now, at that point a flourishing colony which seems well established and likely to increase. This colony will be kept under observation, and whenever egg masses are present in sufficient abundance they will be taken to the mainland and the attempt made to establish them near Anglesea Junction and perhaps elsewhere on the Cape May peninsula. It seems very curious that this insect which finds conditions so much to its liking near Philadelphia, should fail to do well in apparently similar localities in New Jersey.

SCALE INSECTS.

The common orchard scales found the season much to their liking and were all abundantly present. The San Jose Scale which during 1907 was much less abundant and troublesome than usual, recovered lost ground almost everywhere. Many growers who had congratulated themselves on the approaching disappearance of the insect and had neglected to provide spray material or failed to look after their trees, found to their sorrow in late fall that they had rejoiced too soon, and that they had badly infested trees on their hands. So too, some of those who had relied upon untested materials or such as had not approved themselves, like carbolic acid, found that the supposed benefits were due to seasonal peculiarities rather than the application. In all, while the scale has not gained in the State, it has regained much that it was supposed to have lost.

SPHAEROSTILBE ON CHERRY SCALE.

In the Report for 1897 I described at some length the fungus, *Sphærostilbe coccophila* which, in Florida, keeps in check the San Jose Scale, and also the effort to introduce into New Jersey the same disease by means of cultures obtained from Prof. S. A. Forbes, of Illinois, and through diseased scales obtained from Prof. P. H. Rolfs, then of Florida.

Altho we succeeded in establishing the disease, climatic conditions were against its effectiveness in New Jersey and no notable benefit was derived from it. It afterward appeared that the introduction was not really necessary, because the disease already existed in the State and occasionally manifested itself. I found it on trees infested by San Jose Scale in Monmouth County several years ago, and during the early days of September 1908, I found it on *Aspidiotes forbesi,* infesting cherry trees in Burlington County. At this point it was present in quite effective quantity, and on the majority of the trees, none of which were very badly infested by the scale.

This is a new host for the disease in New Jersey, where the scale itself is by no means common. The cherry trees were several years old but not very large, and were bearing, very profitable trees. I had seen them in 1907 and had not noticed any signs of the disease. The important point in the matter is that the same disease, equally a native of New Jersey and

Florida, is very effective as against scales in the hot moist climate of the southern State and absolutely ineffective in the equally hot but much drier conditions of our own territory.

ANTS.

It is not unusual to receive complaints of ants in houses, and usually the small red or black species that get into pantries and provisions are referred to. Sometimes the species that nests in lawns and makes mounds is reported in unusual numbers, but never before have there been as many complaints as during the season of 1908 of the large carpenter ants in houses.

These are active black species, nearly half an inch in length and usually occurring in small numbers outdoors on trees and even on roads. They forage for long distances away from their nests and occasionally a house is included in their range. The insects do not nest in the house at any time; but may be found in a decayed post or beam, or even in a tree stump close to it. Always they build their homes in wood, and never in sound, dry wood.

It is difficult to deal with these insects satisfactorily, since they simply come in from the outside, gather up something in the way of food and make their way out again. It seems that when once a way has been opened the track is followed by others belonging to the same nest, and even if a large number of specimens is killed off, the track is followed by other members and the nuisance seems to be a continuous one. When a condition of that kind occurs, the only thing to be done is to attempt to locate the outside nest and deal with that. Usually it will be found in the immediate vicinity of the house, and sometimes, as already suggested, it may be in a fence post or stair rod, or some other wooden structure attached to the house. If the nest is not easily located the ants should be baited with broken rice, farina or something of that character, which is white and easily seen, and when they have found this and are starting to cart it away, the loaded specimens can be watched and followed to their homes. All sorts of repellants have been tried with very little success, and poisons do not seem to have been more satisfactory.

ANGOUMOIS GRAIN MOTH.

In most sections of the State wheat growers are familiar with this insect, and those that have suffered once are rarely caught a second time; but during the summer of 1908 weather conditions favored the rapid development of the moth in the field, and

there was general trouble among those that delayed threshing until September or later. A very large percentage of the crops gathered became useless for milling purposes and so general was the infestation that the grain from some localities was entirely barred at mills except when ground for the owner.

The general practice is to leave the wheat in the field in shock for some time after it is cut, to mow or barrack it some time in midsummer, and to have it threshed by traveling

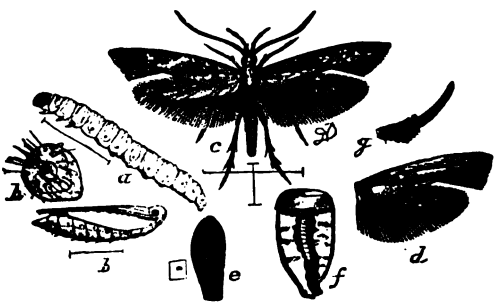


FIGURE 7.

Augoumois grain moth: *a*, larva; *b*, pupa; *c*, moth; *e*, egg, enlarged; *g*, kernel of corn wih larva in place. Riley's figure.

machines during late summer and early fall. This year the early spring weather favored the rapid growth of wheat, the hot dry weather of June hastened its ripening and harvest began at least a week and often two weeks earlier than usual. The insect development kept pace with that of the crop, and the continued dry weather favored an abnormal increase. The grain was mowed about the usual time in a much worse infested condition than it would have been in an ordinary season, and in early September threshers everywhere notified growers that the "fly" was bad in their grain. A clean crop was the exception in most localities.

To those who applied for help I advised binning or sacking and the free use of bi-sulphide of carbon on the material to be used in feeding and the careful selection and storage in tight receptacles of seed wheat, after light treatment with the same material.

As a matter of fact the current practice as above detailed, is all wrong for New Jersey, where this grain moth is always abundant and ready to cause injury. The grain ought not to be left in the field after harvest any longer than absolutely necessary, and it should be threshed, if possible, without being mowed at all. In

the mow there is nothing to prevent continued and increasing infestation; but if the crop is threshed out and the grain is sacked or binned, there will be no further spread. The caterpillars will, of course, mature in kernels already infested, but in tight sacks the moths cannot make their way out and will be unable to reproduce. In the bin, the moths maturing in the surface inch or two will be able to come out, mate and lay eggs; but infestation will be confined to the surface layers where an application of carbon bisulphide will reach them very easily.

This material should be used at the rate of 1 pound for each 100 bushels of grain, and evaporated from shallow dishes placed on the surface of the grain mass, the cover being made as tight as possible. The vapor produced is heavy and sinks gradually through the grain mass, killing all the insects on its way. The "Fuma" bisulphide made at Penn Yan, New York, will answer every purpose and is much cheaper than the material usually carried by druggists. Seed wheat should not be exposed more than 24 hours to these fumes, as otherwise its germinating power will be impaired. For milling or feeding no time limit need be imposed. The bisulphide is inflammable and so is its vapor, so it must never be used near an open light or fire of any kind.

If the practice recommended could be generally adopted, the moths would never be in numbers sufficient to cause serious infestation in the field.

MUSHROOM SCIARA.

Mr. Blake recorded in the report for 1907 some experiments in growing mushrooms in sterilized manure in a cellar protected against the entrance of flies. As the matter of temperature came into consideration I arranged with Mr. John A. Sarles, of Stelton, to make a series of records which would enable us to determine more or less definitely at what temperatures the mushrooms were so attacked as to become unsaleable.

Mr. Sarles houses at Stelton are anything but ideal, and were far from fly tight; but they were improved at my suggestion and the grounds round about were freed of hot manure so as to lessen danger of infestation. Later, as the weather became warmer, a shelter roof about six inches above the shingles was erected to shade the latter from the direct rays of the sun. No effort was made to sterilize or rid the houses of flies. The thermometers used were standard Maximum and Minimum as used by the U. S. Weather Service and readings were made morning, noon and night. The houses were stove heated, and the object was to maintain an average temperature close to 60°.

During the first days of March the flies were swarming in the house under observation, but were not attacking the mushrooms. At this time 46 males and 82 females were taken on the benches and all of these were *Sciara multiseta* Felt. Examined for development, all save 11 of the females had well filled ovaries and Mr. Grossbeck counted in five average examples 80, 85, 87, 77 and 74 eggs. None of these appeared to have laid any eggs. The fact was demonstrated, therefore, that flies with well developed ovaries were present altho no mushrooms were at that time infested.

The observations began March 9th and three records were made on all save five days to the end of the month. On only one day was the record omitted and no observable change in temperature occurred on that. The highest recorded temperature was 65° on the evening of the 27th and on the 26th and 28th it reached 64°. The lowest record for the month was 53°.

The record for April is imperfect because a broken thermometer had to be replaced and a period of eight days was required to renew two of the beds during which time the fire was out. The weather was cool, however, and 64° was recorded on one day only. The minimum recorded temperature was 49°.

Temperatures during May varied greatly. Up to the 12th they did not reach above 64°. On the 13th, 75° was recorded at noon, dropping 12° next day to start on a definite rise May 18th after which temperatures from 66° to 80° were recorded to the end of the month.

And with this rise above 65° the *Sciara* attack on the mushrooms began and continued to become progressively worse until, about June 7th, the crop was definitely abandoned for the year.

During early May when the flies were abundant in the houses, they were found clustering in great numbers at the sources of light, and attempting to get out of the door whenever opened. Mr. Sarles took advantage of that by opening the door for a time during the warm part of the day and permitting the flies to get out in swarms.

From the observations made by Mr. Blake in 1907 and these records for 1908, there would seem to be no reason why mushrooms cannot be grown throughout the season in a properly constructed house from which flies can be excluded, and in which the temperature can at all times be kept at 60° or below. As to the desirability of sterilizing the manure used in the beds, no opinion is expressed; but it should be noted that while the flies with well filled ovaries were already abundant in March, the mushrooms themselves were not attacked until late May, and our

bred specimens are dated June 7th and 21st, from infested plants brought into the laboratory by Mr. Sarles.

When decay begins the mushrooms are attacked by another fly larva, that of *Phora* as determined by Mr. Brues.

CRANBERRY INSECTS.

Like many others, the Cranberry Crop during the season suffered much from adverse weather conditions, and on a short crop insect injury came with especial force. And this injury was not so much chargeable to the vine-worm and fire-worm, which are the ordinarily dangerous pests, as it was to others which are not usually troublesome.

CUT WORMS.

July 1st, Mr. F. S. Gaskill called with a complaint that on his bogs near New Egypt some jumping insect or flea was eating off blossoms and even the tips of vines and causing very serious injury. As the complaint of flea beetle injury was one of old standing which I had never been able to verify, I arranged to go down to New Egypt on the 2nd, and on the morning of July 3rd, got an early start for the bogs. I found that Mr. Gaskill had not in any way over-estimated the seriousness of the injury caused, although it was not due to anything like a flea beetle. The supposed culprit which was present in large numbers was the leaf-hopper, *Athysanus striatulus* which is common on cranberry bogs at all times, and which I found did no appreciable injury. On the areas where the injury was most noticeable fully two-thirds of the shoots had been eaten off, and many buds were indicated only by the bare stems. The work was so characteristic in appearance that I at once began hunting in the rubbish around the base of a plant, and turned out almost immediately a nice fat, pinkish cut-worm, nearly an inch and a half in length and apparently not quite full grown. Mr. Gaskill was just engaged in spraying his bog with bordeaux mixture to prevent injury from scald, and had, on the chance of doing some good, added 1 pound of Paris green to every 200 gallons of mixture. I advised him to add at least 4 ounces more and to spray the infested areas very thoroughly. It was quite easy to recognize the injured places, and they were always where the vines were heaviest, the soil soft and moist, with a covering of leaves and other vegetation. The high, drier places where the vines were short and the surface

hard or sandy were not at all or very little troubled and that was due probably, to the better hiding places which the lower and more densely shaded portions afforded.

Mr. Gaskill followed my advice in the matter or spraying and reported, later, hundreds of dead caterpillars in the ditches and an end to the injury. The bog area covered about 25 acres and the arrangements for spraying were excellent. From the middle of one side a trestle bearing a narrow gauge iron track extended to the middle of the bog: from that point the trestle with its track extended at right angles through the middle toward either end, a turn-table at the junction making a change in direction of car possible. One car is fitted with a 4-horse power gasoline engine and Gould pump under a cover, and a 200 gallon tank. The pump is so adjusted that it can fill by means of a suction hose from the bog ditches, and it has a discharge through 150 feet of ¾ inch wire bound hose, to a T from which two lines of ½ inch rubber hose extend 100 feet and end in a pair of Bordeaux nozzles making a flat spray covering about 10 feet in width. A small trailer car contains barrels with the concentrated mixtures of lime, copper and fish oil soap, as well as other supplies. This trailer car can be run to the shore station while the spraying is going on, and additional barrels of mixtures obtained and brought out as needed. With a force of 5 men the entire 25 acres are thoroughly sprayed in from 2½ to 3 days, depending on weather conditions and minor accidents.

At all events it was demonstrated that cut worms may at times cause serious injury, and that spraying with Paris green is effective in killing them off. It would do no harm in any case to add to the bordeaux mixture when sprayed on a bog, Paris green at the rate of 1 pound in 150 gallons of mixture, until the berries are half grown.

FLEA-BEETLES.

Flea beetle injury to Cranberries has been referred to at various meetings of the American Cranberry Association; but growers have never sent me specimens, nor have they notified me when these insects were present on the bogs so that I might make an investigation.

August 4th, I arranged to visit the Durell bog at Belleplain, one of the oldest bog areas in the State, and one of the most extensive. In company with Messrs. E. H. and F. Durell I went over a number of the bogs and was shown the kind of injury that was charged to flea beetles. It consisted of small areas eaten

from the upper side through the upper cell layer; sometimes only a small patch, sometimes occupying the greater part of the leaf and almost always giving entrance to some kind of disease which resulted in its death. The injury was most severe on young vines and most obvious along ditches or where the growth was rank. On some vines growth had been completely checked, on others it had continued and no permanent injury had been caused. I had just a few days previously received vines showing similar injury from Mays Landing, and am informed that such appearance is not at all unusual on bogs in this part of the State. I was at first inclined to attribute the work to some of the small caterpillars that are known to feed on cranberries; but abandoned this idea after carefully examining the eaten areas. No trace of the culprit was to be found at the time of my visit, but I am strongly inclined to believe that it will prove to be the hudson flea beetle, Systena hudsonica which was observed on cranberries in Massachusetts in 1892. The period at which it does the mischief seems to be about the middle of June and that period will be selected for an investigation in 1909. On bogs which are sprayed no injury is likely to occur, since the beetles feed openly and on the upper surface of the leaves. This is one of the species that would be hit by the practice recommended under the previous heading.

GRASSHOPPERS.

The scant crop on many bogs made the feeding by "grasshoppers" unusually conspicuous, and there is no doubt that a large percentage of the fruit was destroyed by some of the species grouped under this general term. Among other bogs affected were those at Lahaway, where this kind of injury is not ordinarily marked, and Mr. Brakeley was good enough to send in for examination a lot of the specimens which he found on the injured territory. The examination was of very great interest and bore out all previous conclusions that the common, brown, short-horned grasshoppers do not feed on berries while the green long-horned grasshoppers and katydids do so feed. The list of species sent in was as follows:

LONG-HORNED SPECIES.

Scudderia texensis, the common cranberry katydid: 12 specimens, all with well-filled crops containing chewed-up seeds.

Orchelimum vulgare: the largest of the green meadow grasshoppers with a red face: 7 specimens; of which 3 had empty crops and 4 had crops filled with finely chewed cranberry seeds.

Orchelimum Sp.,: a little smaller than the preceding with the face green: 3 specimens; of which 2 had the crop filled with seed fragments and one had not fed.

Xiphidium brevipenne: the smallest of the green meadow grasshoppers found on the bogs, with a longer, straighter ovipositor or egg-laying process than the preceding species: 9 specimens; 3 of them with empty crops and 6 of them with crops filled with cranberry seed fragments.

SHORT-HORNED GRASSHOPPERS.

Melanoplus differentialis: several specimens.
Melanoplus femur-rubrum: many specimens.
Mecastethus lineatus: 1 specimen.

All except the last-named were examined and had only grass and other leaf-tissue in the crop. The difference between the seed and grass tissue is so marked that no mistake in identification is possible, and the result is important chiefly because it fixes, more definitely than heretofore the fact that all of the long-horned green grasshoppers may and under certain conditions do feed on cranberries. My previous examinations indicated that this was rather an exceptional habit with the smaller species, while it was a usual one with the katydid.

Records from those bogs that were sprayed, indicate that the grasshoppers are kept down almost to the vanishing point. The young, unfledged forms feeding on grass and other tissue before the berries are large enough to be attractive are killed off and this furnishes one more reason for spraying where there are not enough of them in other directions.

SWEET POTATO INSECTS.

During the early days of their life in the open fields young sweet potato plants are subject to the attacks of a number of insects that normally cause a great deal of trouble and sometimes serious injury. For a few days after they are set out no growth is made under the best conditions, and if the weather is adverse there may be two weeks or more of rest. It is during this time that the "golden bugs" and the "sweet potato fleas" make their attack and, where they appear in numbers and the plants are small, serious injury is bound to result. The worst offender is the flea-beetle which I investigated in 1891 and 1892 without very satisfactory results. For a few years thereafter very little

was heard of it in Gloucester and Salem Counties; but from time to time and from different localities complaints were heard of injury done. For several years last past the damage in certain sections of Cumberland County and in adjacent areas in Salem County has been steadily increasing until, in 1907, it was said to threaten the profits of the industry and to cause discouragement in some growers. This was brought out during the winter meetings of the County Boards, Granges and Institutes, and it was determined to take up the matter anew in 1908 in the hope of determining some method that would enable us to control it effectively and satisfactorily.

HABITS OF THE FLEA BEETLE.

FIGURE 8.
Work of the flea-beetle on sweet potato leaves.

Thus far we have known very little of the insect except for its activity in the sweet-potato field. We knew that it passes the winter in the adult or beetle stage under stones, in crevices and among the masses of rubbish and leaves at the base of trees in fence corners and similar positions. We knew this because in sifting such material during the winter, specimens were actually found by collectors. We knew also that early in May specimens were found in the hotbeds, making their characteristic channels, while soon after the middle of the month they were present in great numbers and mating. From the middle of May to the middle of June the insects are in the field con-

tinuously, most abundantly during the last days of May and fast lessening by the middle of June. During all this period they are busy feeding, making characteristic channels in the leaves, sometimes on the upper, sometimes on the underside. At the beginning, and while the leaves are in good condition, the eating is done along the leaf veins; but as the feeding progresses all plan seems to be abandoned and there is an interlacing net-work of grooves each eaten through the superficial tissue only, as the result of which the leaf turns brown and dies. When all the leaves on the newly set plant are killed in this way it rarely recovers, and I have seen fields where so large a percentage was killed that practically entire re-planting was necessary. As a matter of course weather conditions go far toward influencing the amount of injury, and the character of the plant is also a factor. A large stocky plant will survive an attack which would destroy a small spindling one, and with plenty of warmth and moisture plants will get a start which, during a drought or a cold wet spell would succumb.

In 1892 I found the beetles hard at work near Swedesboro on May 21st, and they had been noted as early as the first days of that month on plants then set out. In 1907, near Vineland, I found that on May 28th, very few fields had yet been set out, the general tendency being to hold off as late as possible to get beyond the danger period of the insect work. In the hot-beds beetles were found in small numbers and copulating. In the few fields that had been set out the beetles were plentiful, and had done considerable injury.

June 9th drove from Vineland to Norma, in Salem County, and by this time sweet potatoes were out pretty generally. Planting was still going on, but the bulk of the crop was set. The drought had begun, and while the weather was warm the plants were making little start. Several fields were examined and a great difference in the amount of infestation and injury was noted. But even in the worst injured fields the beetles were not very numerous and were obviously decreasing in number.

June 22nd, Mr. Dickerson found a few beetles yet remaining in the fields; but the plants had now secured a good start and where they had not been actually killed down, feeding marks were observed on the old leaves only. July 10th, Mr. Dickerson made yet another examination in this same Vineland territory, and found that the beetles had now completely disappeared while little trace of the early attack could be found on the vines that had survived. An irregular stand in the worst fields spoke eloquently of their earlier presence.

Up to this point our previous knowledge had not been added to. Judging from what we knew of allied species we assumed that the larva would be a slender, white, worm-like creature boring somewhere in the root tissue and to discover this I examined a great many sweet potato and allied *Convolvulus* vines in 1892, without, however, finding any trace of the early stages. On his visits in June and July, Mr. Dickerson duplicated these examinations in the field with no better result, and several vines brought into the laboratory and carefully washed and cut up turned out nothing new.

FIGURE 9.

Larva of Chætocnema confinis, ready to transform to pupal stage. Original.

During the early part of August, Mr. Dickerson found that the common hedge bindweed, *Convolvulus sepium* L., near Chester, in Morris County, showed the characteristic feeding marks of the beetles and a little search disclosed the beetles as well. This led to a renewed search for the earlier stages and this time the soil around the roots of the plants was carefully examined with the result that full-grown larvæ and pupæ were discovered in small numbers. Evidently this was the very end of the larval period, only a few stragglers remaining and even the pupæ being almost all transformed. One of the pupæ taken August 14th, matured August 17th and the identity of the species was definitely established. The larva did not differ from the supposed appearance; but instead of being a borer it feeds externally on the roots of its food plant.

At Vineland neither beetles nor traces of its recent feeding could be found by Mr. Dickerson on August 20th; but on the

25th he found both on sweet potatoes at Little Silver, Monmouth County and on bindweed he found them at several other points on succeeding days. As late as October 1st I found the characteristic channels on bindweed near Trenton in Mercer County.

These observations carefully recorded, supplemented by the incidental observations for several years past and by information obtained from growers indicates the probability that sweet-potato is only an alternate food plant for the insect, that bindweed is its natural food and that it normally breeds on bindweed only, when that is obtainable. It is quite possible that some larvæ develop on sweet potatoes; but that there is no general feeding by them is indicated by the facts that none have ever been found after even careful search, and that in August no general feeding by adults is discoverable, while on bindweed feeding is general. The reason that sweet potato plants suffer so severely in spring is that they are more advanced and offer a better feeding surface at that time than the bindweeds do. Just a little later, when the bindweeds are sufficiently advanced the beetles abandon the sweet potatoes and resort for oviposition to their normal food-plant. This also explains why plants set late are much less apt to be injured than those set early, and it explains why the beetles are not much more plentiful than they are. If they actually bred on sweet potatoes to any extent, their increase would be much greater and their injuries correspondingly much more severe.

LIFE HISTORY.

From the above record the following appears to be the life cycle of the species, *Chaetocnema confinis* Lec. It hibernates as an adult among leaves, rubbish or under stones and becomes active during the first days of May or earlier if the weather conditions permit. It feeds on any species of the *Convolvulus* family, bindweeds being the natural food. Sweet potato plants when they are set out before the bindweed has made a good start are attacked by the hungry beetles which begin to mate about the middle or last part of May; again depending on weather conditions. During the early days of June the beetles begin to desert the sweet potato plants and seek the bindweeds at the base of which they lay their eggs. The larva is white, slender, with six small feet and a distinct yellowish head. It feeds upon the fine rootlets of the plant, but does not bore into them, nor does it seem to cause appreciable injury. The larval period is probably about five or six weeks and the pupal period probably about ten days, bringing the adults to maturity during the last days of July

or first days of August, depending on season and locality. The newly emerged beetles feed on bindweeds, rarely on sweet potatoes, and make the same sort of channels that their parents made in spring. They remain active for a few days only; but seek hibernating quarters after a good meal. All have disappeared before September 1st, although traces of their work on bindweed can be made out up to October 1st and later.

REMEDIAL MEASURES.

There are two methods for controlling or avoiding injury from this insect. The first and simplest is, dip all the plants before they are set out into an arsenate of lead wash made at the rate of 1 pound in 10 gallons of water or even 1 pound in 5 gallons, making sure that all the leaves are thoroughly wet on both sides. Let the plants dry a little before setting; but not enough, of course, to injure them for planting. The roots should not be dipped although no injury seems to result from it. It is simply not necessary. The dipping may be most easily done when the plants are pulled and made up into bundles and a pail of wash will answer for many hundred plants. This treatment protects the plants by killing the beetles as soon as they feed on the poisoned leaves whether they attack the upper or underside, and for this reason dipping is much better than spraying because the latter protects the upper side only. Persistently and generally carried out this method on early set plants will result in the gradual elimination of the species from the locality in which it is practiced, because the beetles are killed off before they have an opportunity to reproduce their kind.

That this method is effective I know, because it has been demonstrated on several fields that were so treated and fully protected. I am aware that it has been claimed that dipping has not proved satisfactory; but all the cases of failure that I investigated proved to be based on material of insufficient strength: in one case only half a pound being used to a barrel of water whereas at least 5 pounds should have been used.

That the method is safe was also demonstrated by using it at the rate of 1 pound in 3 gallons of water without harming a leaf. The report that arsenate of lead injured plants was based on an application where two pounds were used in a pail of water, forming really a thin paste which choked the leaves. Used 1 pound in 10 gallons of 20 per cent. arsenate of lead or 1 pound in 5 gallons of 12 per cent. arsenate, good results will be obtained. In

another part of this report the difference between the different brands of arsenate of lead is explained.

The second method of control is based on the life history and requires no poisonous application. Instead of setting early, delay putting out the plants until after June 1st and, if possible until after June 10th, and then set only large stocky plants, capable of resisting heat, drought and insect attack. It is said, at Vineland and Norma, that plants set as late as June 15th will, in an ordinary season, mature a crop; but there is always an element of danger and that becomes greater with every day after that period. By setting with a machine the time required for planting is so much reduced that it is now possible to begin much later when large areas are to be set out on a single farm. By the 15th of June the bindweeds are large enough to attract the beetles and sweet potato vines will be left untouched or at most will not be seriously eaten. Then wage war against bindweed wherever it occurs and keep it cleaned out, not only in cultivated fields but from hedges and fence corners and along the roads as well.

If the beetles appear in the forcing beds, spray with arsenate of lead, of cover during the day with light muslin frames. It is rare, however, for much feeding to occur in the beds and only isolated beetles seem to occur there.

In any event no grower need worry about this insect which, be it noted, is quite different from that on the white potato. The species infesting the latter always eats little round holes in the leaves: that infesting the sweet potato never eats holes through the tissue but makes narrow grooves or channels which do not extend through the leaf.

THE SWEET POTATO GOLD-BUGS.

Besides the flea-beetles there are three species of tortoise beetles or gold-bugs which are found in more or less abundance and which, for all practical purposes may be considered as one. They also winter in the adult or beetle stage and appear in the field in May, ready to attack sweet potato or any other *Convolvulus* that is available. They get into the forcing beds quite freely; but not so numerously as they do upon the plants in the field and they eat irregular holes through the leaf tissue, so that their injury is conspicuous and at once recognizable. They mate and begin to lay eggs even before the plants start growing; but egg-laying is a long drawn out process and each egg is covered with a little mass of black excrementitious material. Often the

first egg will be hatched before the beetle that laid it has placed the last one of her stock, and therefore by mid-June, adults, eggs and peddlars as the spiny larvæ are called, will be found on the starting vines at the same time.

As against these insects also the dipping into an arsenate of lead mixture will be found effective, and that will protect the plants until they begin to run. After that they will stand any injury from the small number of specimens likely to come on from the outside.

ROOT MAGGOTS. *

Observations upon the root maggots were continued during the season to obtain additional information, and to note such differences as might occur in distribution, time of appearance, etc. As will be noted the insects were somewhat less abundant than in other years and as irregular in distribution. A few experiments were made, particularly with the special fertilizers prepared by Mr. Allen S. Merchant. These were made up of fertilizing materials in the proportions recommended by Mr. Seabrook, based on the results of his experience and in addition carbolic acid at the rate of 4 gallons to the ton, in part, and carbolic acid at the rate of 8 gallons to the ton in the remainder. It was believed that a combination of this kind might prove useful in dealing with the maggots and would be effective if applied at the proper time. The work done and the results obtained are given in the record of observations made at Mercerville on the Black and Riley farms, at Husted on the Seabrook place and at Matawan on the Stemler farm. On these places the maggot conditions had been previously observed as noted in the Reports for 1906 and 1907.

MERCERVILLE OBSERVATIONS.

March 30th: On the Black farm they were preparing the soil for cabbage plants, alongside of the place where they were grown last year. The fertilizer was placed in the rows by means of a potato planter which mixed it up well with the soil. In a few rows the Merchant fertilizer containing 4 gallons of carbolic acid to the ton was used.

April 9th: The plants had been set on both the Black and Riley places, but no cabbage maggot flies were noted. On the

* These notes were prepared by Mr. E. L. Dickerson and record chiefly his own observations and conclusions. The recommendations are based on these.

Riley farm the patch was partly set with cauliflower. A few flies were observed in the Riley patch on the 16th.

April 28th: The Black patch was being cultivated, as it had been several times previously. Cabbage maggot flies were noted and Mr. Black said they had been more abundant on the 25th and 26th. Eggs were observed on plants where both the Merchant fertilizer and the ordinary applications had been made before setting; but apparently some of them had been displaced by the heavy rain of the previous day. Where the Merchant fertilizer had been applied most heavily, some of the plants had been injured by it. The fertilizer containing 8 gallons of carbolic acid to the ton was used as a top dressing about some of the plants on this date. In the Riley patch conditions were similar. A few flies were noted, sometimes resting on the plants, while a slightly larger number of eggs appeared to have been laid than in the Black patch, and were noted on both cauliflower and cabbage. On a few rows where tarred paper disks had been applied no eggs were observed, save on a couple of plants where a very few were found; but these had undoubtedly been laid before the disks were placed. Five consecutive plants on which disks had been used were examined but no eggs noted, while in the next row where no disks had been applied, an examination of a similar number showed 6, 14, 16, 25 and 24 eggs respectively.

May 5th: A few flies still about:—more in the Riley than in the Black patch, so that the period of oviposition had not ended; but many of the eggs had been disturbed from their original position. In the Black patch, particularly, this was noted, and was evidently due, largely, to their method of cultivation, which consisted of harrowing over the plants, with the teeth of the cultivator pointed backward, thus enabling them to disturb the earth about the plants without injuring them. Very few maggots were noted although some of the eggs had evidently hatched. In the Riley patch the majority of the plants, save those upon which the tarred paper disks had been applied, had been treated with carbolic acid emulsion, while in the Black patch the carbolic acid and lime mixture which they used last year was applied to all the plants excepting those that had been treated with the carbolic acid fertilizer. The top dressing of the latter, containing 8 gallons of carbolic acid to the ton, had not injured the plants in any way, but that containing 4 gallons to the ton had burned some young radish plants.

On a few plants in both patches the Cooper V_1 and V_2 fluids,

mentioned elsewhere in this report, were tried at the following strengths to test their effect on the plants.

V_1, 1 part, water 100 parts; V_1, 1 part, water 200 parts; V_2, 1 part, water 50 parts; V_2, 1 part, water 100 parts.

In applying this about 2 ounces were poured around the base of each plant treated. In the Riley patch a few specimens of the small red mite, *Trombidium scabrum* Say, were found evidently feeding on the eggs of the maggot.

May 13th: Root maggot flies had disappeared. On the Black farm very few plants showed infestation, but on the Riley place a number did, particularly on the lower side of the patch among the cauliflower. The carbolic acid emulsion had been used here but may not have been applied frequently enough. Some of the plants upon which the V_1 and V_2 fluids had been used were drying up. On the Riley place there was also an onion patch and in this a number of recently developed onion maggot flies, were noted.

May 18th: On the Riley place treated some infested cabbage plants with the V_1 and V_2 fluids at the same strength as used on the 5th inst., to test its effect on the maggots. Also used it on some onion and radish plants to test its effect on the plants. In all cases the plants were given a liberal application.

May 21st: The results of the treatment on the 18th were noted. The radishes had been burned slightly, but the cabbage plants were very little if at all injured. The effect on the maggots had been variable; in one case the strongest mixture V_1, 1 part to 100 parts of water had failed to kill them, and on the whole it did not seem to be as satisfactory as the carbolic acid emulsion. Among the cauliflower, those plants to which the tarred paper disks had been applied were conspicuous by their freedom from maggot infestation and resulting good appearance; several plants on either side of them showing considerable infestation. The development of the maggots was somewhat irregular; many of them were nearly full grown, some were ready to pupate while a few were quite small. In the onion patch a few flies could still be found.

June 3rd: The Black cabbage patch showed no further signs of infestation, so that it had been practically free from maggot injury; but by the side of the patch a few wild radishes were found to be badly infested. In an onion patch nearby some infestation was also noted. The flies had been observed here about the middle of May, and a top dressing of the fertilizer containing carbolic acid had been applied but had not prevented oviposition. On the Riley place it was noted that many of the cabbage mag-

gots had pupated while on a few cauliflower and some wild radish plants near them, some full grown maggots were found. A very few flies were observed about the patch. In some young onion plants a little infestation was noted.

June 18th: On the Riley place eggs of the cabbage maggot were found about a few of the smallest cauliflower plants and also on some wild radishes in two different spots near the infested patch. On some late cabbage which had been recently set, no eggs were noted, but these plants were some distance away from those which had been infested.

July 16th: No signs of root maggots or flies on either the Black or Riley farms, and the late cabbage on the latter place has not become infested.

October 1st: Found turnips and late radishes growing on the Riley place. Of the turnips there were two lots—an older patch which they were beginning to pull and which showed some infestation, and a younger plot which contained a large number of plants infested with maggots. The radish patch also was badly infested but not quite so badly as the turnip patch. The maggots are for the most part full grown, ready to pupate and it indicates that oviposition occurred in early September. Development occurred so late in the season that these maggots will reach only the pupal stage and flies will emerge next spring.

The Riley plots in part, and the Black cabbage patch as a whole, remained comparatively free from maggot attack, due rather to the disturbance of the eggs by cultivation than to any material used against the insects.

As usual little was seen of the insect during midsummer, but on the Riley farm, the late crops were badly infested.

HUSTED OBSERVATIONS.

March 24th: On the Seabrook place examined the turnip patch which was badly infested in the fall of 1907, and found a number of puparia from which flies began to emerge in the laboratory March 30th—much earlier than under outdoor conditions—and continued to do so during the first two weeks of April. Mr. Seabrook had received the prepared fertilizer containing carbolic acid for onions, cabbages and radishes and, as on the Black place, this was to be applied partly in the rows before planting, and the remainder as a top dressing after the plants had made a start.

April 17th: The prepared fertilizer had been liberally used before setting, and where an unusually heavy application had

been made by accident, the plants had been somewhat injured. A very few of the cabbage maggot flies were noted.

May 2nd: A small number of flies was noted about the cabbage plants and some of the females examined contained eggs. Very little oviposition had taken place in the patch as few eggs could be found, and most of these were on the side nearest to the turnips, which had been badly infested. The plants were being cultivated and in this work the earth was disturbed about them. Mr. Seabrook believes that the eggs would be so displaced by this that the maggot infestation would be checked. The carbolic acid fertilizer applied before the plants were up had not injured the onions or radishes. It had not been used as a top dressing. In the onion patch a small number of flies was noted, and evidently oviposition was in progress although few infested plants were observed.

May 22nd: Infestation of maggot noted in the cabbage and onions; but only small in amount, due evidently to thorough cultivation. A short distance from the cabbage plants and still further from the turnip patch that was infested, were four radish patches. Two of these were early maturing varieties, first pulled April 27th, and showed little maggot injury; the third which they began to pull about two weeks later was badly infested, while the fourth which they began pulling on this day showed no infestation. It is evident that while the first two patches were too early and the last was too late for maggot infestation the third was coming on at just the right time; that is, the time when the flies were about in great numbers: and hence the amount of infestation. These badly infested plants were pulled and destroyed in the hope of preventing the insects from reaching maturity.

October 2nd: Conditions on the Seabrook farm were much the same as at Mercerville. The turnips, which they were pulling on this date, were quite free from infestation. Radishes pulled during mid-September were quite free from maggots, while those now being pulled were considerably injured.

The onions which were set during mid-August, for early spring scallions, showed very little infestation as was also the case with those set about mid-September.

During the summer the insects were not noticed about the plants but, as at Mercerville, occurred in numbers both early and late in the season.

MATAWAN OBSERVATIONS.

June 8th: Visited the Stemler farm and found the onion pa on the whole little troubled with maggot, save at a couple of corners on one side; and there a number of plants were c Carbolic acid emulsion had been used against the maggots, exc on one row where the prepared fertilizer containing carbolic a was applied. Mr. Stemler's general method in this plot wa apply carbolic acid emulsion as soon as the plants were up, continue at frequent intervals until the early part of June. plants were fertilized, applying the material along the rows, s after they were up and nitrate of soda at the rate of 125 pou to the acre was to be used about July first. The special carb acid fertilizer was applied to the row receiving it, soon after plants were up, at the rate of 1 quart to 100 feet, and the appl tion repeated twice, at 10 day intervals, thus making a tota three applications and 3 quarts to 100 feet. This was the c treatment this row was to receive, save the application of nit of soda in which it shared with the others. The plants i looked somewhat better than the rest, due perhaps to the met of applying the fertilizer, but so far as maggot infestation concerned there was little difference between that row and rest of the plants. On this date most of the maggots in the s number of infested plants were full grown or nearly so, whi few were quite small and on one plant several good eggs w noted. Mr. Stemler said he had observed the flies about middle of May.

These onions were situated alongside of the plot where t were grown last year, when several hundred bushels were g ered, and of these only a very few bushels were infested v maggots. These were destroyed and it is largely due to thi believe, that this year's plants were not worse infested.

Mr. Stemler also had a small number of cabbage plants an few of these had been infested; some of them he believed become so in the cold frame. The worst infested plants in plot were taken out, while the remainder were given sev applications of carbolic acid emulsion with the result that infestation was checked.

Some of the infested onions were taken to the laborat where flies were bred from them during the latter part of J

June 18th: Several other onion plots in the vicinity of M wan were seen, and while none of them had made the stand t Mr. Stemler's had, owing to the lack of similar cultivation

fertilization, nevertheless the maggot infestation had not been bad in any of them.

A few infested onions were gathered and from these the following flies were obtained on the dates given:

July 31— 9 ♂. 13 ♀ *Phorbia ceparum.*
Aug. 1—11 ♂, 1 ♀ " " and 5 *Euxesta notata.*
Aug. 3— 8 ♂, 4 ♀ " " " 7 " "
Aug. 5— 9 ♂, 13 ♀ " " " 1 *Tritoxa flexa.*
Aug. 6— 1 *Phorbia ceparum*, 1 *Euxesta notata* and 2 *Tritoxa flexa*
Aug. 7— 1 *Tritoxa flexa.*

Sept. 25th: The onions on the Stemler place had been gathered and out of the 300 bushels about 3 bushels were found to be infested with maggots; about 1 per cent. of the crop. The row receiving the special carbolic acid fertilizer had been treated as planned, while the rest of the plot on the 15th of June received a top dressing of the regular onion fertilizer used by Mr. Stemler, and which was equal in amount to the 3 dressings of the carbolic acid fertilizer on the one row. In the field there was a little difference in favor of the row treated with the special fertilizer, but in other respects the conditions were unchanged. The few bushels of infested onions gathered with the rest were destroyed, and as a result his next year's onion plot will be saved from a large amount of infestation.

There were no check rows in the plot as a basis for comparison, and there was no evidence that the carbolic acid fertilizer had much effect in checking the maggot. In fact, it seems probable that the careful gathering, last season, of all infested onions was mainly responsible for the small amount of infestation this season.

Some of the infested onions were brought to the laboratory. The maggots they contained were for the most part well developed and nearly ready to pupate, and as none of the flies had emerged up to November 5, it is in the pupal stage that they are hibernating.

SUMMARY AND RECOMMENDATIONS.

From the foregoing records and our observations in past seasons, it is evident that few of the cabbage root-maggots hibernate as adults; but that the great majority, if not all, pass the winter in the puparium stage. Both in radishes and turnips the full-grown maggots are found as late as end of September and early October, and the past spring in March, puparia were collected from a badly infested turnip patch and from these puparia, flies emerged in early April. In the fields, the flies were not observed

until the middle of April, both sexes became abundant during the later part of the month and continued in evidence through the early part of May.

Egg-laying began during the latter part of April and early May and maggots were found on the plants during the latter month and in early June, when most of them had entered the pupal stage. Little or nothing is seen of the flies during the summer and the crops are not troubled by them then. But in late August or early September plenty of them appear, as is evidenced by the heavy infestation of the late radish and turnip patches.

Very early radishes which were pulled in late April were not attacked because they were matured before the eggs of the insect had hatched, or the maggots had begun feeding. Those plants, radishes or cabbages, present in the fields in late April and early May suffered most, because that was the time when the flies were present, while the plants after this time suffered little, because the period of general oviposition had passed. Plants during the summer, including late cabbage and early turnips, were not troubled; but late turnips and radishes present in the fields in early and mid-September suffer much because it was on them that the flies, which were in the field at that time, oviposited. It is true that the earlier turnips did suffer somewhat from the maggot attack; but they were large and tough and did not suit the flies nearly so well as the younger and more tender plants.

The onion maggot flies were noted in the field somewhat later than the cabbage maggot flies, and infested onions were noted throughout the season. From maggots collected in the field, flies were bred in the laboratory July 31st, August 7th, while in September, when the onions were gathered, a number of them contained maggots, which are hibernating as puparia.

There was no evidence that the fertilizer containing carbolic acid had been of any benefit in checking the maggot although it may prove that it does if applied at just the right time. If applied before the plants are set, it appears to be of little value and injurious to the plants when too heavy an application is made; and even as a top dressing it did not prevent oviposition.

The V_1 and V_2 fluids used liberally upon maggot infested plants proved of little value. As to the carbolic acid emulsion there has been no indication as to what strength of carbolic acid has been used save in the case of that used by Mr. Stemler, which was 96 per cent. The infestation was only slight in Mr. Stemler's onion patch and this may have been due, in part, to the applications of the carbolic acid emulsion that he made. But on the other hand, it is more probable that it was due to the clean cul-

ture. At any rate, the emulsion as made up by Mr. Stemler was weaker than usual and this material will have to be tested another year with an acid of a definitely known strength.

Thorough cultivation was of considerable importance. In both the Black and Seabrook cabbage patches particularly, the chances for infestation were strong and eggs were noted in the plots in numbers; but the amount of maggot infestation was very small and this was due, apparently, to the thorough cultivation which dislodged the eggs before they were hatched. This is possible on cabbage and cauliflower and to some extent on onions. Several growers have stated that if there are heavy rains about this time there is likely to be only a small amount of infestation and that is in all probability also due to the fact that the eggs are displaced by the washing or beating water. The younger maggots are very helpless and do not easily find the plants if not close by.

Clean culture also has been indicated as of importance. In the fall of 1907 Mr. Stemler when gathering his onions collected both good and bad, and the latter, which were maggot infested and amounted to several bushels, were destroyed. The result of this work was apparent in the condition of his plot in 1908. There was some infestation, but small in amount, and the work just mentioned, rather than the applications made in the plot, was responsible for this, I believe. In like manner the destruction of infested radish and turnip plots in the fall of the year would be of value. If this work is done just as soon as the infestation is noted and the plants are removed and destroyed before the maggots have a chance to pupate, the number of insects to seek the plants in the spring for purposes of oviposition would be much reduced.

As a protection to the cauliflower and cabbage plants the tarred paper disks proved to be both practical and effective.

The recommendations are then, to remove whenever possible all plants infested with maggots and destroy them. This should be done as soon as possible and before the insects have a chance to pupate. When possible, cultivate frequently and thoroughly about the plants, close enough to displace the eggs; it will be of little value after the eggs hatch. Tarred paper disks will prove effective and can be used on cauliflower and cabbage. They should fit snugly about the plants, should be placed as soon as the plants are set, and it does not matter if they become somewhat covered with dirt. When these methods cannot be used the carbolic acid emulsion is suggested as this appears to be the most effective material that has been used about the plants. The emulsion should be made of 90 per cent. crude carbolic acid and with

1 pint of acid, 1 pound of soap, and 1 gallon of water, diluted with 30 gallons of water for use.

RECORDS OF THE EXPERIMENT ORCHARD.

No winter application of scale-killing materials was made and no systematic summer spraying was done. Such materials as were tried proved ineffective and the trees are, at the end of the season of 1908, worse infested than at any time within three years; yet no single tree is really bad.

A warm spell in late March forced the trees into a start which was checked by a cold spell reaching the frost stage in early April. Peach blossoms began to open on the 20th, cherries a day or two later. Pears were blooming April 26th and 27th, while apples did not open until the 29th.

May 18th, sprayed trees 1, 2, 8, 18, 19, 29, 30, 31 and 38 with, a combination of arsenate of lead and bordeaux mixture sent in for trial. This at the strength applied caused marked injury, especially on the apple; but in view of certain irregularities in effect I decided to test the matter further and sprayed once again, May 25th, trees 1, 2, 8, 18, 19, 31 and 38. The injury was intensified and the apple fruits badly marked. Notified the makers of the result and the material was withdrawn from the market until a better combination could be produced.

August 24th, trees 2, 38 and 40 were sprayed with the Bogart Sulphur solution, 1-20 so as to hit trunks and larger branches thoroughly. September 15th, duplicated this application on tree 2 and thoroughly sprayed trees 18 and 19 and the small apple trees. At this time each of these trees had a large brood of larvæ on the move.

Tree 1.—Mariana Plum. In bloom April 25th, set heavily May 10, foliage badly injured by hail a little before this time. Sprayed with a combination bordeaux mixture and arsenate of lead May 18 and May 25, causing some injury to foilage. All save a dozen fruits dropped and October 25 the trees was yet in good foliage, with a very decent scale infestation on some branches.

Tree 2.—Yellow Transparent Apple. Sprayed with Cooper's V_1 fluid, 1 part in 100 gallons of water and covered thoroughly all except tips of twigs. Buds began to open April 29, was in full leaf with most of the blossoms gone May 10. May 18 and again May 25 sprayed with combined bordeaux mixture and arsenate of lead causing much spotting of foliage and some on fruit. Scale larvæ were first noticed June 18, more than any

her tree on the place. June 20th, sprayed with the Talmadge phine 1-20 that part of tree showing most infestation; but could d absolutely no good result next day. August 24th, larvæ re again moving in large numbers, and I sprayed with the gart Sulphur Solution 1-20. Applied first so as to get at the nk and larger branches that were most scale-infested, then m the outside of the tree to reach the leaf-hoppers on the out- e. The effect seemed good on the larvæ and very recent sets; next day there was a new lot of active specimens afoot. Re- ted the application September 5th, this time aiming at the le-infested areas only. On the 13th found that the results re as before—only larvæ and very recent sets killed. Matured nall crop of rusty fruit. October 25th leaves were dropping t, there was a good peppering of scale on the older wood; but y little on the twigs.

Tree 3.—*Black Tartarian Cherry.* Came into bloom about y 1st, made and ripened a good crop of fruit, a large part of ich was taken by robins. Remained free from scale through- the year and began to drop foliage October 25th.

Tree 7.—*Champion Peach.* A ragged looking tree with much d wood. Buds began to open April 14th, made a heavy set of it which remained small and ripened slowly. September 13th, all fruits were yet off but rot was bad and the flavor was poor. e scale did not develope much although some could be found all times. October 25th, leaves were dropping fast and only a derate infestation was recorded.

Tree 8.—*Baldwin Apple.* Leaf buds opening April 14th, ssoms opening April 29th, bloom scant. Sprayed with arsen- of lead and bordeaux May 18th and again May 25th, and sed a decided spotting of foliage. The tree did well although crop was small, partly crippled and wormy. The best fruits re taken off October 25th, at which time the foliage was yel- v, brown and mottled. Crawling larvæ were yet on the nches with plenty of recent sets in some places.

Tree 15.—*Japan Golden Russet Pear.* Blossom clusters began separate April 14th, in full bloom on 26th, and in full foliage ay 10. Made a very heavy set which did not come up very well d did not mature until mid-October. Much of it cracked, some s wormy and some rotted. Scale developed in some quantity, d by the end of October was scattered all over the tree.

Tree 16.—*Japan Golden Russet Pear.* The general history is nilar to that of the preceding, but it is on the whole a poorer ee. There are just as many scales and, in addition, on the

trunk, a terrific number of mites and their eggs. Every little nodule has a cluster of eggs of mites or of cast skins around it.

Tree 18.—*Vermont Beauty Pear.* Started April 10th, in bloom April 28th, made a very moderate set of fruit May 18th, on which a little midge and a little curculio work was noticeable. On that day and again on the 25th, sprayed with the combined arsenate of lead and bordeaux which did not cause as much injury as on the apple. The tree developed the best crop of fruit it has ever borne and the midge injury was slight. There was a slight sprinkling of scale which intensified later in the season and, October 25th, with the leaves nearly all off, there was some scale all over: a very good percentage of it on the tips.

Tree 19.—*Vermont Beauty Pear.* The general history is like that of the preceding, but it is a somewhat better tree. The crop of these two trees was really good although the fruit was not quite so large as it should have been. But that was due to the season.

Tree 20.—*Meech Quince.* Made a start early in the season and then died without obvious reason. Cut out.

Tree 23.—*Greensboro Peach.* Buds began to open April 15th, and by May 15th had a very heavy set of fruit. Made a very good crop, beginning early in July and running through nearly three weeks. Grew well during the season and promises well for 1909. October 25th the foliage was almost all off, and there was plenty of live scale on all parts of the tree.

Tree 24.—*Greensboro Peach.* A slighter, more lanky tree than the preceding because of its shaded situation. Made almost as good a crop and has quite as much scale on it.

Tree 25.—*Apricot.* Was in full bloom April 14th, set no fruits and grew rank all season. October 25th, was yet in almost full foliage with only a little scattering of scale.

Tree 26.—*Late Peach.* This has been listed as a Nectarine and was received from the nursery as such. It never matured a fruit before, but this year made a fine crop of very late (October) large, white, smooth peaches of very fine flavor: variety not determined. At no time was there much scale visible and, on October 25th, there was just enough to call the tree infested.

Tree 29.—*Gravenstein Apple.* Leaf buds opened April 14th, blossoms April 29th, made a scant set of fruit. May 18 sprayed with combination arsenate of lead and bordeaux mixture, and duplicated the application on the 25th. On the 27th serious injury was apparent. Much of the foliage was brown spotted and burnt and other leaves were turning. A small crop of nice fruit

ripened. October 25th, about half the foliage was off, the tree was in excellent condition and there was little apparent scale.

Tree 30.—*Grimes Golden Pippin.* Leaf buds opened April 14, in full bloom April 30. Made a moderate set and was sprayed with the arsenate of lead and bordeaux combination May 18 and 25. Injury to fruit and foliage was marked; but not so bad as on No. 29. The fruit developed slowly and much of it was wormy and crippled. It proved altogether inferior to anything the tree had previously borne and it ripened in early October in bad shape. The small fruit is largely due to the season: the worm infestation is due to the ineffectiveness of the material used in spraying and part of the crippling I believe to be due to the same cause. There was less leaf-hopper than usual and no scale noticeable on the apples harvested. On October 25th the foliage was just beginning to turn and very little scale was noticeable.

This is the only one of the apple trees that bore a full crop of fruit and its infested condition was in marked contrast with last year's record. It emphasizes the effectiveness of proper spraying because in 1906 when there was no spraying at all the apples were equally wormy.

Tree 31.—*German Prune.* Leaf buds opened April 15, blossoms April 28, and soon after a nice set of fruit was made. Sprayed May 18 and again May 25 with arsenate of lead and bordeaux, which did not seem to injure the foliage materially but did very seriously affect the fruit. On one side or the other each shrivelled and many dropped after reaching good size. Others, less injured continued to develope and some ripened, the last being removed September 13. Not a single perfect specimen was matured and I charge the spraying with the result. October 25th the foliage was yet nearly all present, and a little scale was everywhere noticeable.

Tree 32.—*Mountain Rose Peach.* Blossoms opened generally April 14 and foliage came slowly afterward. Made a good set and matured a heavy crop of fair fruit. October 25th it was in very good shape, rather too slender limbed, with fruit buds only at the tips of shoots. Scattered scale only and much of it recent. Foliage mostly gone.

Tree 35.—*Japanese Walnut.* Made its usual good growth during the year, made no crop and was no scalier than usual.

Tree 38.—*Baldwin Apple.* Leaf buds opened April 15, blossoms opened irregularly and over a long period beginning April 29. Sprayed May 18 and again May 25 with combined arsenate of lead and bordeaux and noted decided injury to foliage a day

or two thereafter. Only a small number of fruits set a developed very unevenly; most of them somewhat cri wormy. A few really fine examples were taken off 25th. Sprayed August 24, with the Bogart Sulphur 1-20 to test it for injury to foliage and effectiveness agai hopper. The application was all from the outside, there attempt being made to get at the trunk or branches whil contrary, every attempt was made to hit those insects tempted to fly. No injury developed as the result of t cation, but I could not find that the leaf-hoppers had be reduced. September 13 the insects were more plenti ever, and the foliage showed the characteristic effects feeding. October 25th, the tree was yet in full foliage only a mere trace of scale.

Tree 42.—*Elberta Peach.* In nearly full bloom April made a good set of fruit. May 25, part of this tree was tally sprayed with the arsenate of lead and bordeaux tion when treating No. 38. It received only a scatteri but was almost defoliated; every leaf that was fairly hit Later the shoots on the side toward the apple died as t of the defoliation and left a lop-sided plant. Augu sprayed with Bogart's Sulphur Solution 1-20 simply t effect on foliage and found no harm resulting. Octo the tree was in very poor condition but had very little s

Tree 43.—*Early Richmond Cherry.* Blossomed full the first days of May. Made and matured the best set it has ever had and made a very good growth. On Octo it was yet in almost full foliage and never looked bet scale apparent.

Tree 46—*Japanese Chestnut.* Started into leaf developed well through the season and matured a small very good nuts in October. While it is still a small tree, it is in better condition than ever before and has n

Tree 47.—*Greensboro Peach.* Blossoms began openi 15 and a heavy crop of fruit was set and matured. Dev was slow, the fruit was under-sized and the quality not as it should have been. October 25th the foliage was ready to drop, there was a decided scattering of scale, m recent, and some larvæ were yet moving.

Tree 48.—*Black Tartarian Cherry*...Started well blossomed full and made a phenomenal set of fruit. tured well, was largely harvested by robins and the tree its usual good appearance to October 25th, when the fo yet almost perfect and no scale was apparent.

INSECTICIDE NOTES.

ARSENATE OF LEAD.

This material has increased in favor to such an extent that there are now at least a dozen if not more manufacturers whose product is regularly on the market while other firms are considering its production.

One objection to the material has been that it did not run at all uniform in strength. It is marketed in paste form and there is a wide variance in the amount of water contained in this paste and the consequent percentage of actual arsenic, upon which its real effectiveness as an insecticide is based.

At a meeting of manufacturers with a committee of the economic entomologists at which the writer was in attendance it was agreed that in order to be considered a proper material arsenate of lead should contain at least 12 per cent. of actual arsenic in combination, not over 1 per cent. of which should be soluble in water and not more than 50 % water.

In Bulletins 213 and 214 analyses of the brands sold in New Jersey will be found, and from these it appears that with one exception all manufacturers reach the required standard while a number of them greatly exceed it. As to the effectiveness of the material every year brings additional testimony, and its use is increasing continually.

MISCIBLE OIL.

This is now the most usual material for San Jose Scale work on other than peach trees, and there are at least three new combinations now on the market, in competition with Scalecide, Target Brand and the 95% oil referred to in my last report.

One of these "Spray Oils," made by the Vacuum Oil Company of Rochester, N. Y., was distributed in trial ½ barrel lots to a number of growers in New Jersey and three of these lots were sent at my request to.

Mr. Isaac Hildabrant, New Germantown.

Mr. James McCracken, Middlebush.

Mr. J. G. Cortelyou, Rocky Hill.

In each case the material was applied at the rate of 1 part to 15 parts of water and the treated trees were first examined by Mr. Dickerson to ascertain the extent and character of the infestation.

After midsummer Mr. Dickerson verified the reported results, and the trees at New Germantown were also examined by myself.

At Middlebush, Mr. McCracken used this Vacuum oil in comparison with Scalecide and Target Brand and applied as follows:

On March 20th, 1908, divided an orchard of 850 pear trees and an equal number of Japanese Plums into three equal sections. Sprayed the eastern plot with "Target Brand," the central plot with "Vaccum oil" and the western plot with "Scalecide." All were of equal strength, 1 to 15 and were applied liberally to pear and plum alike. Air was moving from the northwest. The three days following were clear, cold at night, and warmer by day. Considerable rain fell March 23rd.

March 31st with wind from Southeast, sprayed the western plot with "Scalecide" and central plot with "Vaccum oil." This was immediately followed by rain. The "Target brand" did not mix so well as the others and the application was not duplicated.

July 6th Mr. Dickerson found that results were practically equal in all plots and that it was almost impossible to find live scale. Mr. Dickerson credits this result to the thoroughness with which the work was done and the liberal dose of material that was applied.

Some large apple trees sprayed at the same time, but not so thoroughly, showed a slight infestation.

In the Cortelyou orchard apple and peach trees had been sprayed with "Scalecide" and "Vacuum oil" and at first it was believed that some of the younger peach trees had been killed by the applications. But on examination it was found that about 100 trees had died from winter injury on an ill-drained area underlaid by a very dense and compact clay. A gas sprayer was used here and there was some trouble with all the material; but more with "Vacuum Oil" than with "Scalecide." As to results, there was little to choose between them and both had killed practically all the insects reached.

The Hildabrant trees at New Germantown were examined by Mr. Dickerson March 5th, May 25th, and again with me, July 7th, and here the "Vacuum Oil" came into direct comparison with the Lime and Sulphur wash which is the general reliance on peach trees in this section.

A long row through a 6-year-old bearing orchard had the oil treatment, as against the lime and sulphur elsewhere and so far as the scale is concerned the oil did as well as the other. But the leaf curl had been very bad in this orchard even on the lime and sulphur trees and the oil treated trees not only suffered more but

recovered more slowly so that, in midsummer, the row did not, on the whole, look as well as the rest of the orchard:

On a younger peach orchard it was noted that the oil treated trees did not start quite as early; but that was hardly a drawback and in midsummer these trees were fully equal to the others.

Besides these the Vacuum Oil Company sent me the addresses of seven other fruit growers who had received some of their oil and this was in general applied as directed, 1 to 20, and without any especial care. Results therefore were variable so far as I could investigate, ranging from absolute failure to reasonably complete success; but in no case so good as in the cases already recorded.

But the Vacuum Oil was not alone in this irregular result. Near Dover I examined, in midsummer, a large orchard of apple and peach which was so badly infested last year that I would have advised cutting out a large percentage of the peach trees at least. It was absolutely drenched with "Scalecide" in the spring of 1908 and in early August (11th) I did not find more than half a dozen living scales during the two or three hours I spent among the trees. At Hammonton, on the other hand, Mr. Dickerson examined a peach orchard in early September which, in spite of a thorough treatment with "Scalecide" in the late fall of 1907 was so badly infested that it demanded immediate and radical action. The reason for the failure it was impossible to ascertain; but it was the only one of its kind in our experience this year.

Another new material is the "San-U-Zay" scale oil, also made in Rochester, N. Y., and sold by F. G. Street and Company at 32 cents per gallon in barrel lots and 40 cents in 10 gallon cans. This is a departure from the other materials on the market in that it must be diluted with soda-water; i. e., it requires 3 pounds of sal soda to every 50 gallons of water, and the recommendations is to use 1 part to about 12 of water. This material has not yet been tried out in New Jersey, hence nothing can be said at present of its effectiveness. Samples are in hand, however, and will be tested during the ensuing winter.

"Carboleine" is a new product put up by the B. G. Pratt Company, the makers of "Scalecide" to duplicate the home-made miscible oils, formulas for which were given in the report for 1907. They guarantee the formula given in their circular and state how it can be made at home if desired.

The formula and directions are:

Carbolic acid	2 gallons
Red oil	2 ½ "
Potash	8 pounds
Heat to 300° F. and add	
Petroleum or kerosene	5 gallons
Water	6 "

The above is the emusifier which is combined as follows:

Emulsifier	8 parts
Petroleum	22 "
Water-about	1 "

For use dilute with from 10 to 15 gallons of water. This sells for 33 1-3 cents. per gallon in 30 gallon lots, and for 30 cents per gallon in 50 gallon barrels.

I have not tried this combination nor have I seen it used, so know nothing of its effectiveness. It should, however, be quite as useful as the combinations for which formulas were given from Delaware and Connecticut.

APHINE.

This is a material prepared by Mr. George E. Talmadge, of Madison, N. J., and has the appearance of a liquid tobacco soap, One gallon of the material was received for trial during the winter of 1907 and experiments were begun with it in early April. The material had been used in New York City park work by Mr. E. B. Southwick, who found it very effective as against certain plant lice; but had made no systematic tests.

Tried it at first diluted with only one part of water to determine what, if any injury it would cause on plant life, and found it practically safe on peppers, pansies, petunias, bean and egg-plant seedlings, all in the greenhouse. It spotted flowers to some extent and scalded the most tender leaves a little; but practically it could be considered as harmless.

A 40 per cent. mixture on mullein killed all the plant lice infesting it, harmed no leaves; but did injure the blossoms.

Rose-bushes badly infested with plant lice were sprayed, June 1st, with mixtures varying from 10 per cent. to 40 per cent. with equal effect in all cases and no injury to the plants.

June 4th, sprayed green lice on cabbages and black lice on cherry with a 5% mixture and killed all the specimens. Check plants and twigs had the insects remaining in good condition, so that the benefit is attributable to the material entirely.

June 6th, tried the 5 per cent. mixture on the lice curling elm leaves and killed all that were reached by the spray. In this

case it was necessary to uncurl the leaves to some extent to admit the material; but it cut the waxy bloom covering the insects very effectively.

June 10th, used a 2 1-2% mixture on plant lice infesting English Ivy, and on black lice infesting Dock. All the insects were dead next day. Spraying dock plants with a 1% mixture was not so effective although some of the insects were killed.

June 20th, sprayed some branches of elm infested by slugs of the elm beetle, with 2 1-2 and 5% mixtures. The 5% mixture killed all the larvæ which were less than half grown; but the 2 1-2% mixture left a small minority unaffected.

June 22nd, sprayed two small apple trees on which scale larvæ were just setting with a 10% mixture, which proved practically ineffective. Very few of the newly set scales were killed.

In the green house, on the same day, sprayed some carnations infested with red spider with the 2 1-2% mixture; but a week later there was no difference whatever between the sprayed and unsprayed plants.

Also treated two fern plants infested with mealy bugs with the 2 1-2% mixture, without beneficial results. There were just as many mealy bugs the week after the application as there were before.

We have, therefore, an extremely effective insecticide with a very narrow range. In the garden and greenhouse it cannot be excelled as against plant-lice by anything known to me, and in the field it will probably do as well provided the price is sufficiently low.

PICRIC ACID.

Early in the year Dr. A. E. Nienstadt suggested that possibly Picric Acid, which is an intensely bitter material, might be useful either as an insecticide or as a repellant, to protect foliage and prevent it from being eaten. This seemed rather a good suggestion and at my request Dr. Nienstadt prepared two lots of the acid; one on them containing an adhesive, the other without this admixture. The material was first tried on foliage to test it for injury, and it was found that no harm resulted from even a very concentrated mixture.

As elm leaf beetles were plentiful at this time; a large number were gathered and placed under bell-jars with a sufficient amount of foliage to feed upon. After twenty-four hours the unsprayed foliage under one bell-jar was very badly eaten, there were several fresh egg-masses and all the beetles were healthy. Under

a second bell-jar, one twig was sprayed, the second was unsprayed. The unsprayed twig had the foliage badly eaten, the sprayed twig was not touched. Under a third bell-jar all the foliage was sprayed. None of this foliage was eaten, several of the beetles were dead, and the only egg masses were on the cover of the glass jar and none on the foliage.

This seemed a decidedly favorable indication, and outdoor experiments were made on elms and maples continuing from May 29th to June 12th. Unfortunately the results of the indoor experiments were not duplicated by the outdoor applications. Whether the leaves under the bell-jars were kept more moist, so that the acid was more active or for some other reason, at all events the outdoor foliage, when sprayed, appeared to be just as attractive forty-eight hours after the application as it was before. Used on plant lice at all strengths the material seemed to be ineffective.

In order to test it further, I sent a gallon of the concentrated mixture to Mr. George A. Mitchell, at Vineland, with instructions to dilute with 10 parts of water and spray on grave vines infested with rose chafers. June 9th, Mr. Mitchell reported to me that he had applied it very thoroughly on infested vines. All parts were covered until the foliage dripped. Next day the beetles were collected on the sprayed row and on the row next to it and the specimens counted. The result showed a very decided advantage in favor of the row that had been sprayed. There were fewer beetles and the leaves had been much less eaten. Two days later the collections were duplicated, the beetles were again counted and this time the result was reversed. The vines that had been sprayed contained many more beetles than those that were unsprayed and the foliage was now much more seriously eaten. The vines were kept under observation for some time afterward and when the beetles disappeared they were quite as much injured as any other in the same vineyard.

Picric acid is decidedly unpleasant to handle and stains intensely both the clothing and the skin, so as it seemed to offer no reasonable prospect of effectiveness, experiments were discontinued.

CARBOLIC ACID.

Inquiries still come concerning the carbolic acid treatment, and occasionally some one claims that trees treated with a banding of this material have become free from the scale. As Mr. Dickerson was near Flemington on nursery inspection work September 29, he made opportunity to call on Mr. Thatcher and to look

at his orchards. There was no treatment with acid this year, nor were the trees sprayed in any way. The peach orchard is again becoming infested; some trees considerably, some trees only a little and this was to be expected because when the trees were dehorned some had all the infested wood cut off and some had a little remaining. The latter trees are now getting bad again, while the former are just re-infested. The apple orchard does not differ from previous records the lack of treatment resulting in no more serious infestation than before.

It has developed that some pear trees have been injured by the acid banding and that it will not do to band successive years in the same place.

Another grower near Cherryville informed me that his peach orchard had been kept in fair condition with lime and sulphur until last year and in 1908, instead of continuing this treatment he used the carbolic acid: the result is a seriously infested orchard that will need radical treatment this winter to bring it into good condition for next year.

CARBOLIC ACID EMULSION.

There have been curiously contradictory experiences in the use of "carbolic acid" emulsions and in the use of washes including "crude" carbolic acid as one of the ingredients. In the references to this material for purposes of banding, it developed that under the general term "crude," there might be anything from 25 per cent. to 100 per cent. actual phenol or carbolic acid and, of course, the two extremes would give altogether differing results. The standard formula for a carbolic acid emulsion calls for 1 pint of crude carbolic acid, 1 pound of hard soap and 1 gallon of water and this, when emulsified was to be diluted about 30 times with water. Now if one individual uses as 100% crude and gets excellent results, and another a 25% crude and fails to secure any benefit, the matter is not at all mysterious, provided we know the facts; but actually, crude carbolic acid has been bought and used, absolutely without regard to its percentage of phenol and in consequence all our experiments and the recommendations based on them are unreliable because we do not know just what sort of material we have worked with. In all our work with carbolic acid emulsion against root maggots we do not know anything definite about the strength of the acid used except that the different lots were not alike. In only one instance in the root maggot experiments was the actual grade of the acid known, and it means, practically,

that we must arrange for an entirely new series of experiments to determine the effect of the material on plants and on root maggots. Hereafter, when crude carbolic acid is referred to either in recommending its use or in recording results, the actual percentage of phenol in the material used or to be used must be given to make matters definite.

CARBOLIC ACID FERTILIZER.

During the winter of 1907-'08, Mr. Allen S. Merchant, of Farmingdale, suggested that if carbolic acid was a good insecticide on root maggots and underground insects generally, it might be a good scheme to combine it with a fertilizer that would reach the roots directly and might thus have a two-fold action on plants and insects. The fertilizer material represented by Mr. Merchant was peculiarly adapted to absorb a certain quantity of liquid acid and, theoretically, his proposition seemed a very attractive one, well worthy of trial; especially as he agreed to meet any composition that was deemed desirable for the crops to be treated.

After some correspondence with Mr. Merchant and Mr. Seabrook, three formulas were agreed upon and a quantity of the product was furnished to Mr. W. E. Black, of Mercerville; Mr. L. H. Stemler, of Matawan, and Mr. Arthur P. Seabrook, of Husted. These materials were:

Onion fertilizer,	4% N.	7% Ph.	7 % Pot.
Cabbage fertilizer,	3% N.	7% Ph.	5 % Pot.
Radish fertilizer,	9% N.	4% Ph.	2½ % Pot.

To this was added Crude carbolic acid at the rate of 4 gallons and 8 gallons per ton, this being absorbed and held in the material that was used as a carrier for the other chemicals.

Unfortunately here too the carbolic acid played us a trick, for two lots of material were purchased, both without specification of percentage of phenol desired and, as it developed afterward, one lot almost twice as strong as the other. It proved impossible also to determine the lots that received the stronger acid, so the possibility remains that some of the material had fully four times as much actual phenol as the rest of it, and all our results are left in rather an indefinite and inconclusive position.

Mr. Merchant was very courteous and very liberal in his dealings with the Station in this test, and thanks are due to him for the interest that he manifested in the experiments. The results obtained, so far as there are any, are detailed in the record of root-maggots experiences, and to these it may be added that ex-

periments much better guarded will be continued with material of known strength.

LIME AND CARBOLIC ACID.

The trees treated with lime about the base and those banded with carbolic acid on the College farm and in the Experimental Orchard were kept under observation throughout the season, and it was found that on those which survived, the scales bred as freely as where no applications had been made. One acid banded tree on the farm died as the result of the treatment and one was badly injured. In the Experimental Orchard two of the acid trees died. None of the lime-treated trees showed any ill effects and, indeed, the trees did very well indeed. The two Vermont Beauty pear trees treated with lime had very little scale in 1907, but during the summer of 1908 breeding took a new start, and in the early fall there were more scales than there had been at any time for three years past. And that is also the record of the other treated trees.

BOGART'S SULPHUR COMPOUND.

During the latter part of the summer I received from Mr. W. H. Bogart, of New York City, a material which he claimed was pure sulphur with a carrier to make it soluble in water. It had an intense sulphurous odor, was syrupy in consistency, caustic to the touch, dissolved readily in water and left no sort of precipitate. It was a very beautiful combination and very attractive in appearance. Mr. Bogart claimed that it could be used on badly infested trees, at the rate of 1 part to 20 parts of water, to kill San Jose Scales, and that where the infestation was more moderate, 1 part to 30 parts would be sufficient, especially if repeated within twenty-four hours. Good results were also claimed for a dilution as high as 50 to 1.

Of the one gallon jar received in early August mixed up half a gallon on the 24th of that month, at the rate of 20 to 1, and applied in the experiment orchard to two large apple trees and a small peach tree. The application was pretty thoroughly made; but only to the inside of the tree to get at the scales and to the outer surface, so as to get the effect of the material on the leaves and against leaf hoppers. Also sprayed the small apple trees that were set out last year, and these were thoroughly coated, so as to cover everything. As the application in this instance was

intended to reach leaf hoppers, which were very abundant, the air around the trees was also filled with the fine mist, so as to hit flying hoppers.

The next day there was little appearance of the material remaining, and no sign of injury to foliage on any tree. The scale larvæ had evidently been killed and there were not so many leaf hoppers; but whether this was due to the fact that a large number had been killed off, or that they had gone to other trees, could not, at this time, be determined. The morning when the examination was made was cloudy and chilly, and the insects were not readily started. Later the trees were again examined, and at no time was there any appearance of injury to the foliage from the application.

It was found that while the crawling larvæ and some very recent sets had been killed by the application, the breeding scales had not been affected, nor those that had reached the gray stage. In a few days larvæ were just as abundant as before and the gray scales had changed to black. The material had not been any more effective than a soap mixture, or a weak kerosene emulsion would have been.

I was not ready to accept this as a satisfactory test of the material, and handed over the remaining half gallon to Mr. M. A. Blake, our Horticulturist, with the suggestion that he use it in the green house on red spider and similar pests. Later Mr. Blake reported that at the rate of 1 to 20 it was quite effective against the red spider, and also that he had found it excellent in the control of mildew on roses.

In order to give the material an orchard test, Mr. Bogart sent eight gallons to Mr. John S. Collins, of Moorestown, and this was used in part on his orchard near Merchantville and in part on the Arthur J. Collins place at Moorestown. Treatment had been made on apple, pear and peach trees that were seriously infested by the San Jose Scale. It was in fact, a very severe test for any material, because some of the treated trees were fairly incrusted, and larvæ were swarming at the time in almost countless numbers. On September 16th I covered the territory on which the applications had been made, and found that that while perhaps most of the crawling larvæ had been killed by the applications, the breeding scales had not been injured in the least, and that the trees were again alive with active larvæ. The application in this case had been at the rate of 25 parts of water to one of the sulphur compound, Mr. Bogart claiming that the weaker mixture would be better than that which I used.

Several rows of young apple trees were treated by Mr. Arthur

J. Collins. The infestation here was slight but obvious, and the application was through. Here also the same record was to be made, and only uncovered larvæ had, apparently, been reached by the insecticide. No injury that could be charged to the solution was discovered.

Mr. Bogart was not yet satisfied, and at my request, sent a gallon of the material to Mr. Howard G. Taylor, at Riverton. There was some delay in the application; but when the sprayed trees were examined by Mr. Dickerson during October, he found practically the same condition of affairs that I discovered in Moorestown and Merchantville.

Some tests were made earlier in the season as to the effectiveness of the material against elm leaf beetles; but the results were not sufficiently definite to make them worthy of reliance. Apparently the sprayed branches were less eaten by the beetles and their larvæ than were those nearby; but as this marked about the period at which the larvæ were transforming, their disappearance from the foliage was to be expected.

It can hardly be said that this material has had a thorough test as to its range of usefulness; but more than probably it will be found much more active as a fungicide than as an insecticide, and it is a question whether as an insecticide, it will not require a combination with lime, to make it sufficiently caustic to affect scale insects. Here is a line of experimentation that seems worthy of being followed up further.

LIME AND SULPHUR.

The use of this material has not increased so far as the home-made mixture is concerned; but there has been a very decided increase in the use of the commercial preparations, several carloads of them having been disposed of in the State and applied with generally good results. The two brands most generally used were the "Rex," made by the Rex Company, of Omaha, Nebraska, and the "Niagara" brand made by the Niagara Sprayer Company, Middleport, New York. So far as I was able to see and learn from those that used them, both brands were equally satisfactory and, at a dilution with 9 parts of water, acted as well as the home-made mixture. The cost of the diluted mixture is a little in excess of the cost of the boiled material; but of course there is the saving in time, labor and outfit and there is no waste of material from imperfect mixtures or crystallization before use.

The James A. Blanchard Company, of New York, has also a prepared lime and sulphur wash which I have not seen tested in the field; but which apparently is very similar to the others in composition. It will probably prove as effective as the others.

These commercial preparations bring the material within reach of the small grower who was deterred by the cost of the outfit and the trouble from making and using it.

On peach trees the mixtures, home-made and commercial, have again demonstrated their effect on the peach curl; orchards sprayed with them being uniformly less injured than those treated with oils and much superior to those untreated. Some injury was obvious this year, in all orchards.

During the winter, Mr. B. F. Hires, of Bridgeton, brought to my attention a powdered material which he claimed was a combination of lime, sulphur and salt which, when stirred into boiling water at the rate of one pound to the gallon, produced a combination equivalent to the standard mixture. It had been tried locally, apparently with success, and Mr. Hires was good enough to let me have a quantity for trial. This I tested in the laboratory sufficient to determine that it really made a combination resembling the normal mixture and then sent it to Mr. Howard Taylor, at Riverton, with instructions for use.

June 30th Mr. Dickerson examined the four plum trees to which it had been applied and found that there had been, apparently, some difficulty in getting the material to stick to the smooth terminal shoots. Where it had stuck it had been quite effective, although less so than would be expected of the standard wash. The material might, it seems, be developed so as to stick better and of greater strength. It need hardly be said that for convenience in handling and transportation this would be far in advance of the liquid concentrates. It illustrates a new line of experiment which promises well for the future.

Another material was "Glutrin" received from the Robeson Process Company of Ausable Forks, N. Y. This is a lime and sulphur combination not directly prepared as an insecticide, but apparently an incidental product. One barrel of this was sent in, with directions to dilute with 3½ times that amount of water and the material was shipped to Mr. Isaac Hildabrant, of New Germantown, who used it on Peach and Apple trees, in direct comparison with the standard lime and sulphur wash. In May the report was that while the Champions sprayed with the home-made material were free from curl, the "Glutrin" trees were quite badly infected. In August when I visited the locality and saw the treated trees, the conclusion was that while there may have

been some benefit from the treatment it was not sufficient to authorize a recommendation of the material for practical use.

Cooper's V_1 and V_2 Tree Sprays.

These are combinations put on the market during the past year, and are partly the result of work done in the Cooper Research Laboratory in England, and partly the result of experiments made by Mr. Walter H. Collinge, Economic Zoologist, and lecturer in the University of Birmingham, England. In his Reports on the Injurious Insects and other animals observed in the Midland Counties of England, Mr. Collinge refers to successful experiments made with these and other materials, but says nothing of their composition, except to state that they are too complicated to be made up by farmers or fruit growers. Mr. Collinge also appears to be in the employment of the Cooper Laboratory. The V_1 mixture is for winter use, the V_2 mixture is a summer spray. Both are to be diluted with 100 parts of water, and for both it is claimed that it will kill about everything in the insect line from egg to adult, one application serving for the entire season.

The Chicago branch of William Cooper & Nephews very courteously sent me one gallon samples of both materials and later a second supply of the V_2 or Summer Spray. Experiments began in February in the Laboratory and in the field, and included eggs of plant lice (Lachnus Sp.), eggs of bag-worms, eggs of the tussock moth, oyster shell scales and scurfy scales. All treatments were made by completely immersing in the diluted mixture and various strengths were employed up to 1 to 25. The laboratory experiments were all highly favorable in results. The check lots of plant-lice eggs all hatched in due time: none of those that were treated developed, although for a long time no apparent change could be discovered in the eggs. From the treated bags not a single caterpillar emerged and that was the record for the egg masses of the Tussock Moth. From check lots of both species caterpillars were obtained at the proper period. It should be said in this connection that with the bag-worms the bags were cut open and the pupal shell was broken to give the liquid free access to the eggs.

Oyster shell scales infesting lilac twigs were dipped into 1-50 and 1-100 dilutions and kept with a number of checks. Larvæ appeared from the latter June 9th, while none developed on either of the treated twigs.

On the other hand, I painted the lilac bush from which twigs for experiments were obtained with a dilution of 1 to and in June the treated portions were just as full of larvæ a recent sets as any others.

About this time the inner branches of tree 2 were sprayed w the same material, because considerable San Jose Scale was n ticed in some places. There is no memorandum of the dilutio but it was probably 1-100. There was no appearance of obvio benefit later, when breeding began. There seems to be no dou that the material has very decided killing powers; but it need much further trial before it can be confidently recommended. Judging from appearance and odor it contains alcohol and some Cresol compound.

With the V_2 material the results were less encouraging. Experiments began in the greenhouse April 29th on plant lice infesting mullein, which were sprayed with the 1 to 100 dilution. This was absolutely ineffective 24 hours later and the application was renewed at double strength or 1-50. There was no immediate effect and nothing evincing discomfort on the part of the insects some time afterward. Before the greenhouse was again visited the treated plants had been removed.

Lilac shoots infested by oyster shell scales from which young were hatching in the greenhouse, were sprayed April 29th at 1-100, and examined next day. The application had apparently killed the then moving larvæ; but there was another batch then moving about showing that the material has no lasting powers and that it will not penetrate beneath the scales even when larvæ just hatched are beneath them.

May 1st pansy plants in greenhouse, infested with plant lice, were sprayed with the 1-100 dilution. A few days later lice were still present although in apparently reduced numbers, while the foliage showed material injury apparently due to the application. It should be said that in all cases the applications were made with an atomizer at close range with greater force and thoroughness than would be ordinarily possible in regular greenhouse work or in any field work.

May 5th both V_1 and V_2 fluids were tested, in the field against cabbage maggots with negative results as appears more fully under the cabbage notes.

June 1st, sprayed the 1-100 mixtures on rose bushes infested by plant lice and applied very thoroughly. No apparent benefit was derived from the application and a few days later the plants treated with this material were worse than ever, while others treated with the Talmadge mixture were entirely clean.

June 11th, sprayed the lower branches of a walnut tree infested with oyster shell scale with a 1-50 mixture, applying to drench. The young scales had just set and were covered with the first waxy coating. June 20th very little effect was noted. If any had been killed it was not noticeable. Made another application using a 1-25 mixture, or four times the recommended strength. June 29th, there were few dead scales to be found; except in a few little spots they were growing well and showed no appearance of check or harm from the application.

June 15th, painted infested lilac bushes with a 1-50 mixture. These had been earlier treated with the V_1 fluid and the larvæ had recently set and formed new scales. This application was quite effective, a considerable percentage of the young scales being found dead a few days later. It seems to indicate that painting is more effective than spraying, because the species on lilac and walnut are supposed to be identical.

June 12th, a large *Euonymus* on the College Campus, badly infested by the *Euonymus* scale was sprayed with the 1-50 mixture. The larvæ had recently set and there was a heavy infestation of lightly covered specimens. The application was very thorough and the bush was drenched in all its parts. Examined a day or two later the results were very unsatisfactory, more living than dead scales being found, and late in the season the bush, while not quite so badly covered as another that had not been treated, was still in very bad condition and densely infested.

June 20th, six young apple trees were treated with a 1-25 mixture on the College Farm. These trees were moderately infested with San Jose Scale, a few larvæ were yet crawling, there was a good sprinkling of white sets and a few had passed to the gray stage.

June 29th, it appeared that the larvæ and most of the white sets had been destroyed; but the more advanced forms had escaped and were developing normally. So at 4 times the recommended strength the material was not sufficiently effective to make it reliable.

The record is not altogether encouraging although no doubt the material has some merit. The winter mixture has had scarcely a sufficient test for lack of opportunity, and for the summer mixture our results do not altogether agree with results obtained elsewhere. At the L. I. Railroad Experiment Stations, Mr. H. B. Fullerton obtained excellent results with the V_2 mixture on cabbage lice and on a number of other species. He finds the recommended dilution of 1 to 100 too great, however, and uses 1-70 to obtain satisfactory results. In a communication

from Mr. Fullerton it is recorded that he obtained satisfactory results also against larvæ and recent sets of the San Jose Scale and his record of applications made is clear and not liable to lead to erroneous conclusions.

Under the circumstances the mixtures seem to deserve thorough trial for another season at least, and these will be arranged for.

REPORT ON THE MOSQUITO WORK FOR 1908

Report on the Mosquito Work for 1908

By John B. Smith, Sc. D.

The work during the fiscal year from November 1st, 1907, to October 31st, 1908, was carried on along the same general lines as last year: there was a little scientific investigation and a great deal of practical work. The assistants during the year were continued as in 1907. Mr. H. H. Brehme chiefly in charge of the actual marsh drainage work, Mr. J. A. Grossbeck in charge of the Laboratory and draughting work as well as inland inspections, while Miss A. E. Meske has attended to the clerical work.

The total appropriation for the fiscal year amounted to the sum of $20,000.00, with which work was done as follows:

Drained Area	Acreage	Feet of ditching	Cost	$20,000.00
Long Beach Tp.		150,000	$3,600.00	
Secaucus	416	51,350	795.00	
Compton's Creek	920	58,400	900.00	
Pew's Creek	320	25,700	498.00	
Montclair Heights		3,000	250.00	
Keyport Town	150	19,000	315.00	
Raritan Tp. (Middlesex)	150	15,000	300.00	
Raritan Tp. (Monmouth)	872	90,000	1,600.00	
Madison Tp.	1693	209,000	3,100.00	
Matawan Tp.	612	87,200	1,500.00	
Brick Tp.	1536	180,000	2,600.00	
Total	6669	888,650	$15,458.00	15,458.00
Leaving as cost of administration				$4,542.00

As a matter of fact nearly $300.00 of this sum for administration was spent in small jobs such as cleaning ditches, adding spurs not previously deemed necessary and the like.

The total work done up to the present is:

Acreage	Feet of Ditching	Total Cost to State
17,620	2,394,174	$34,858.00

No acreage is mentioned under the Montclair Heights heading because that is not marsh land, and none is mentioned under the

Long Beach heading because by an error the entire acreage between Barnegat Junction and the New Inlet was included in last year's report whereas only half of it was actually completed out of the appropriation for that year.

The season of 1908 was an abnormal one in many respects and favored the development of mosquitoes of all kinds. The heavy rains of early spring favored the upland and inland forms so that they got a start which sent them into every hole and corner containing water; while on the salt marsh the frequent and unusua high tides covered and filled the depressions again and again. the hot sun of midsummer raising the temperature so rapidly that a week served to bring to maturity every brood on the undrained meadows.

This point is an important one to keep in mind: that the breeding on the salt marshes is very little dependent upon the amoun of rainfall. A heavy tide in the midst of a long continued drought may fill every pool on a salt meadow and as the eggs hatch within a few hours after they are covered, a brood will mature in every depression that is over three or four inches deep. The high grass and reeds on such meadows retards evaporation and a week serves to reach the adult stage. On a low meadow there are usually three or four tides on a perigee moon that cover or nearly cover and as the water lowers the larvæ follow from the level surface to the depressions, so that sometimes a pool becomes so crowded that not all of the specimens can be at the surface at the same time. There is thus a constant shifting, the specimens below forcing their way through for an air supply, while the others dive for food until they in turn must fight for a surface position. In a shaded pool larvæ and pupæ may survive in the soft ooze for twenty-four hours; but they cannot stand a hot sun for more than a short time even in a wet mud.

While all these conditions, resulting in a "mosquito year" might be considered unfortunate from one point of view, yet as it was probably the worst that is ever likely to happen, it taught us a great deal about breeding places that will be useful in future work.

Another interesting matter was developed in the study of the eggs on the salt marsh and the probability that an individual ovum may maintain its vitality for two or even three years. This is brought out in Mr. Grossbeck's notes on the season's work. He also brings out that in the same identical woodland pool three different species may appear in three successive years each species by itself and without any admixture of the species that was in the same pool at the corresponding time of the previous year. The in-

dications here too are that the eggs may lie dormant for a period of at least two and probably three full years. With all these developments in mind the problem grows not only more interesting but also more complicated for even tho in a given wood lot every larva in every pool was prevented from coming to maturity, there might, the year following, be an equally large crop in every pool though of a different species.

Culex pretans was this year the most abundant species for a time in the Great Piece Meadows, and on May 30th in the height of their season a party of excursionists entered it with six horses. Within an hour every shrub and bush near the camping place was hung with blood-filled mosquitoes; hundreds of them being on the horses continually; new hordes arriving as those that were blood-filled left. The excursionists themselves were scarcely less attacked but better defended and therefore lost not so much blood!

The following is a record of the work done in the order of geographical sequence, from north to south.

BOROUGH OF SECAUCUS.

The breeding territory along the Hackensack River and Penhorn Creek contained about 416 acres and we calculated that it would require about 57,350 feet of ditching to make it safe. Proceedings were begun in March, and in due time the contract for the work was awarded to Mr. Jesse P. Manahan on March 21st, 1908, for $795.00. The meadow offered no unusual difficulties and was done by hand work, a new type of spade invented by Mr. Manahan being tried out for the first time. It approved itself and, well within the time limit, the work was completed April 14th.

This was one of the few instances where no unexpected troubles were encountered and where everything went as planned.

Later in the season, after the heavy rains of May and accompanying high tides, the marsh was again visited and everything was found in good working order. There had been some floating of sods in the heavy floods that had swept the meadow; but they had been mostly carried off down the river or had been washed against the old embankment of the Greenwood Lake Railroad. As in other localities a few *sollicitans* got out here late in May; but that ended the career of these meadows as mosquito breeders during the season of 1908.

HACKENSACK MEADOWS.

It seems almost impossible to convince those living within range of these meadows that they are not responsible for a very large percentage of the mosquito troubles in the region, and therefore I have kept this area under observation more closely and continually than almost any other. In our surveys for the Jersey City work in 1907, we had gone northward as far as we found any trace of salt marsh breeding and believed that we had hit every place that was at all dangerous. Late in the season came a flight that disturbed this belief and indicated that under certain conditions a small territory along Penhorn Creek and just north of the Jersey City line, most of it in the Borough of Secaucus might produce a sufficient brood to prove troublesome.

Both Mr. Brehme and Mr. Grossbeck went over the surrounding territory several times, and finally determined the utmost limits of probable danger. The large cat-tail areas along the River were again and again traversed by these gentlemen and always with the same negative results, whether the meadow was wet or dry. It seems probable therefore that we have gotten to the head of the salt marsh breeding territory in this valley and that our previous conclusions as to its status as a mosquito breeder must stand.

JERSEY CITY.

An early inspection was made of the salt marsh that was drained during the spring of 1907 to determine what, if any, damage had been caused by the winter storms, and up to the end of March not a ditch was blocked and not a pool of water remained on the meadow. The early broods of cantator *larvæ* emerged and were killed off before the middle of May. After that the persistent rains and high tides maintained so high a water level that a small brood of *sollicitans* came to maturity. By June 2nd, directly after the heavy downpour of May 30th, the meadow was again dry because the lower run of tides permitted the ditches to do their work and thereafter, until mid-September, no breeding occurred on this meadow, to the marked advantage of the residents of that section of the City. Early in the summer Mr. Delaney, the member of the Board of Health in charge of the mosquito work, sent a gang of men to clear each ditch of grass and other debris and this undoubtedly helped matters. In September a very heavy crop was on the meadow and in harvesting

this some of the ditches were blocked for the convenience of drivers and this caused an overflow of a small section and some breeding before it was discovered.

This is really the chief danger to the work: natural agencies we can guard against; but the ignorance and wilful stupidity of owners or workers cannot be provided for. It may require further legislation to sufficiently protect these drains from interference.

It was also found that under exceptional conditions a small marsh area on the Claremont section would breed some mosquitoes and $350.00 was expended by Mr. Delaney out of his appropriation to ditch this territory.

Throughout the season the sewer basins and other breeding places in the City were kept under supervision and freedom from mosquitoes was greater than in almost any other City. Mr. Delaney's organization is one of the most effective in the State.

BAYONNE.

This City has a small area of very bad breeding territory and the attention of the authorities was formally called to the matter in the late fall of 1907. The matter was taken up in due course by the Board of Health and the Council and they elected to do the work themselves, under their own supervision. It was estimated that $500.00 would do the required work and an outline plan of what was needed was furnished. The $500.00 was voted by the city but the plan was not followed and, while conditions have been materially improved, they have not been corrected to the extent that was expected. Nevertheless the improvements that are in progress in that general territory will rapidly narrow the breeding area and will gradually eliminate the mosquitoes. Two or three hundred dollars properly expended now would give permanent relief at once.

POINT-NO-POINT.

This is the territory comprising the triangle at the Junction of the Hackensack and Passaic Rivers, south of the line of the Pennsylvania Railroad. It is a low marsh, largely covered by reeds and cat-tails, has been partially dyked and is crossed by broad blind ditches that make excellent mosquito breeding places. The ownership is in the Newark Meadows Improvement Company and they are filling in a section of the territory by means of Hydraulic dredges stationed in the Passaic River. A very large

part of the area has been already sand filled, and on this no further breeding occurs. The operations have invaded part of reed-covered territory and have changed conditions there to some extent, so that what was safe territory in 1906, now breeds some mosquitoes.

Several broods of varying extent emerged in 1908, and were noticeable in North Newark, in Arlington and at Kearny at intervals during the season. But there were not, on the whole, any very large numbers.

A conference with the officers of the Improvement Company indicates that the period during which this trouble will continue must be very brief. Work is being continued and many tons of sand are daily spread over the marshes, covering an ever-increasing area and burying the eggs on the covered surface. It is hoped that some covering will be spread over most of the remaining danger area before the next breeding season begins in 1909, and at the worst there can be only very small numbers.

In view of the character of the work now being done no measures that would be temporary in character seem advisable.

NEWARK.

During the summer of 1908, the board of health has maintained one, and part of the time two men on the marsh to look after the ditches and prevent interference with the drainage. Except during May no broods came out on this area and no breeding went on to any extent except on the tract overflowed by the sewage from an imperfect trunk crossing it.

A portion of the territory is being filled and of course this is eliminated as a danger point. A new railroad spur has been run across a part of the meadow; but culverts have been put in at all main ditches and excellent connecting ditches have been put in to maintain the present drainage scheme: something no railroad engineer ever paid the least attention to in olden days.

A line of water-pipe has been extended to one of the factories on the shore, and the dam carrying this interrupted the drainage for some distance. Ditches were dug parallel with this line to intercept the water and carry it to an open line to the Bay.

The extension of Doremus Avenue cut the main line of drainage without provision for carrying the water across it. But this was cured, when attention was called to it, by a culvert through the avenue, and a ditch parallelling it on each side. A new outlet ditch over 1200 feet long and 20 inches wide was also put in under the auspices of the board of health. Altogether several

hundred dollars were expended by the various departments of the City in maintaining and improving the drainage of the meadow. The results were obvious and in no season were there fewer mosquitoes on these marshes than in 1908 and the examination of sod samples shows that the eggs on the meadow are rapidly decreasing in number. Practically the entire *cantator* broods were destroyed early in the season and on the many times when I spent the night in Newark City during the season, I was not once bitten by a salt marsh mosquito and saw very few of them.

Nevertheless there were a few early in the season, and after midsummer the house mosquito became a veritable pest, breeding in the sewer basins and at other points in the City. The conditions that led to this are elsewhere described and the organization did not rise to the demands of the situation until so late that not much practical good was accomplished. The board of health has always supported the work, and while the results in 1908 left much to be desired, it at all events taught a lesson that will be useful in the future.

LYONS FARMS.

Lyons Farms lies between Newark and Elizabeth, and is building up into a very attractive, residential section. A part of it is sewered; but most of the places still depend upon cesspools and there are many cisterns as a source of water supply in whole or in part. Complaints of mosquito troubles reached me early in June and these proved, on investigation, to be due to the salt march species *C. sollicitans* which had come up from the Elizabeth meadow, and were then near the end of their period.

Other complaints in July referred to the house species *C. pipiens* and after a consultation with some of the interested residents, I sent Mr. Grossbeck over the territory to locate the source of the trouble if possible. There are several little ponds and one small creek within the Farm limits and these were first examined with negative results, although a few *Anopheles* and other larvæ were found. A little swamp area along the Lehigh Valley Railroad and a large duck pond also showed *Anopheles* larvæ in small numbers.

Pipiens larvæ and pupæ were found in numbers when cesspools and cisterns were examined, and there seems little doubt but that these furnish the chief sources of supply. There is nothing in the situation not fully within the power of the local board of health acting with the householders and in an advisory capacity.

ELIZABETH.

None of our drained meadow areas were quite so badly the May conditions as those at Elizabeth. Of all that in area west of the line of the New Jersey Central Railroad small part drains into Bound Creek, while all the balanc find exit through the narrow channel of Great ditch. In or seasons this ditch is taxed to the fullest extent; but in the of 1908 it proved utterly inadequate. The tides ran so hig at best there were only two hours of outflow between the this left the upper end of the ditch practically unaffected. in March and April the meadow was practically dry and n quitoes developed, the conditions in May were the exact o and not until almost the middle of June was all the water meadow. And during that period conditions on the Staten shore opposite were not much better and two very broods of *sollicitans* matured here, providing south Eliza section of Newark and some of the territory to the west respectable swarm for a short period. After mid-June the no further trouble. The condition was so bad, however, th Richards, the Health Officer, planned to raise money to and straighten Great Ditch and to increase the capacity o of the main ditches that empty into it. It was also discove midsummer, that by a change in the sewerage system of th the burden on one of the lines that emptied into a little cr the meadow was more than doubled, without a corresp increase of the outlet. This produced a sewage pond hic the tall vegetation, that produced such swarms of *C. pipie* cause complaint and consequent investigation. About was spent for a ditch sufficient to carry this sewage to a outlet and, when I saw it, the territory had been laid pra dry. It was notable that after the May troubles, salt mars quitoes were very rare, even at the edges of the meado children in bare legs and feet played among the grass an vegetation without annoyance, while babies were asleep riages in the streets without nettings—conditions which the meadows were drained were never believed possible.

Elizabeth still has many cisterns, and in these mosquito ing began earlier in the season than ever before. About fourths of the original number of cisterns have been elin and of those that remain the majority are well protected. city conditions are constantly improving, and during most season catch basins were looked after to prevent breeding.

once was a brood allowed to get out by a delay in oiling. North Elizabeth adjoins Lyons Farms, in which cisterns and cesspools are present and breed a supply sufficient for themselves and their neighbors.

If Mr. Richards succeeds in carrying out his plans for 1909, there will be less mosquito trouble in that year than ever before.

LINDEN.

This meadow was examined in late March and all drains were clear, in good condition, and worked perfectly. During the summer quite a change was made in some sections of the territory. The Standard Oil Company acquired some hundreds of acres and began putting up immense storage tanks and other structures and railroad spurs were run into this territory. In all the work done the scheme of drainage was preserved and even added to, so that matters are the better for the change.

One of the large manufacturing plants added to the ditches placed in their territory and, as a result, very few mosquitoes developed on this meadow during the season.

The last inspection was made October 13th, and everything up to the City of Rahway was found in excellent condition, in strong contrast to the state of affairs two years ago, when this whole area was mosquito breeding territory.

WOODBRIDGE CREEK.

This area was ditched in 1907 and kept under observation during most of the season of 1908. This meadow differs from those to the north in that it has a very considerable admixture of clay that makes drainage very slow. It was a very rotten meadow at best and a large number of ditches were put in to take the water. The work was done very late in the season by Mr. Edwin M. Skinner, of Staten Island, who used a spade of his own contriving in the work. The tool is excellent and the work was well done; but the sods taken out were small, did not have a chance to grow fast before winter set in, and many of them floated during the winter; some into the ditches so as to block them.

During March the meadow drained off clean and some of the owners gathered up the sods into piles to burn when dry. Later on the meadows were flooded by rains and tides and kept waterlogged until well along in June, quite a large brood of *sollicitans* developing in consequence. It was deemed wise, under the circumstances, to put the meadow into better condition and for over

two weeks two men were employed in cleaning out ditches, using the sods to fill holes or otherwise disposing of them. As a result subsequent broods of larvæ developing were pretty generally killed off, but in the deeper holes water always remained long enough to bring some of them to maturity. Furthermore, along the creek some dredging was done under a government contract, and the sand was deposited along the bank, covering some of our ditches and restoring about two acres of marsh to ugly breeding conditions. It was impossible to restore drainage on this area because no permanent ditches could be carried through the sand filling and, as the understanding is that the filling is to be carried further eventually, matters were left as they stood.

Altogether this meadow is in a less satisfactory condition than any of the others in this region and it will be a matter of some considerable time before all the eggs work out of it. Enormous numbers of larvæ were killed off every time the meadow became covered and drained off, and the developing broods were comparatively small in consequence, especially late in the season; but the egg supply still on the meadow is large, and some broods will inevitably come to maturity here in 1909, though the trouble will probably be much less than in 1908.

In the adjacent municipality of Perth Amboy the drainage work was done by the marsh owners at the orders of the board of health and, in general the work was well done; but there was also some sloppy work and some that is ineffective, hence there is a likelihood of continued trouble here also.

Although the conditions are not so satisfactory as could be wished, they are vastly improved over those of early 1907. At that time some parts of the marsh appeared to be practically bottomless and composed of a soft clayey ooze. At the present time these places are firm and the entire meadow tends to become more level and even in character. As these improvements continue the breeding areas will become more and more limited, this consummation being delayed somewhat by the clay admixture which impedes the percolation of the water and restricts the effectiveness of the ditches.

RARITAN RIVER MARSHES.

The marshes lying along the Raritan River, some in Raritan and some in Sayreville Township were ditched in 1907 and were kept under observation throughout the season of 1908, some inspections made by Mr. Brehme and some by Mr. Grossbeck, beginning March 31st and ending October 1st.

The winter caused no injury to our work and at the first inspection the meadows were dry and the ditches ran clear. By the middle of May the heavy rains and storm tides had changed matters somewhat for the worse. It was found that some sods had floated into the ditches, others had become covered with floating grass and it needed looking after. Nevertheless there was no mosquito breeding on the drained territory although, quite evidently, many larvæ had hatched and had been killed off.

It developed also that under such conditions as those of May, the upper end of the meadow, on which no breeding had ever before been observed, might become troublesome, for there were now many little pools in it kept alive by the frequent rains and in many of these a few wrigglers developed. There were not a great many anywhere; but the aggregate on the meadow meant quite a perceptible brood and it was determined to put the meadow into proper condition.

The sum of $300.00 was therefore applied to put in 15,000 feet of ditches in the newly developed breeding area and in cleaning out the few blocked ditches. Later in the season brood after brood of larvæ was killed off in the depressions, filled mostly from high tides, and few mosquitoes developed on the meadow as a whole. There were, nevertheless, plenty of mosquitoes on the meadow, coming over from the Cheesequake territory, and there is no doubt a heavy crop of eggs now on this marsh. Perth Amboy and South Amboy got only partial relief from the drainage work done because of their proximity to the Cheesequake area; but at New Brunswick the difference was strongly marked and after a small flight early in the season I saw no specimens of the species from this region. At my house close to the River we had fewer mosquitoes than ever before in our experience there.

In September our attention was called to the presence of salt marsh mosquitoes in Metuchen, and in locating their source we were led to the upper end of the Raritan meadow which had again become water covered by high tides from the creeks and had developed a brood of *sollicitans* sufficiently large to get into the upland. This meadow like some of that at Woodbridge is partly clay coated and from these coated pools the water does not drain rapidly. The depressions are neither large nor deep and they never contain many larvæ; but there are so many of them and the meadow is so low that a series of high tides will keep them full long enough to bring a brood to maturity. A great number dried off all right; but some of the deeper ones, most remote from the ditches did not.

The most interesting feature of the whole matter is that n breeding was observed on this area at any time in 1906 and 190 although it was looked over again and again, and in the origin surveys made by Messrs. Wagner and Mellor in 1904 this w marked as a safe meadow. I am quite positive in my belief th this is the first time in three years that any larvæ have develop and these have come from the accumulation of eggs for th entire period. As appears elsewhere in this report a clay botto is not an attractive place for oviposition, so eggs must be scant scattered over the entire meadow. Even when the larvæ we concentrated in the pools they were always few in numbers co pared with those in a muddy marsh pool.

Considering the history of this clay-covered area it was det mined to allow it to work itself safe. Of the mosquitoes develo ing here few will oviposit, most of them migrating to mo attractive places and, in spite of the slow drainage the vast m jority of all the pools are laid dry before the wrigglers come maturity. Each brood therefore will be smaller than the last a it is expected that, while some specimens will be found on t meadow for years to come, these will not be sufficient in numb to spread in noticeable numbers beyond the edge of the uplan That large area along the River which had previously been mos prolific in mosquitoes bred very little during 1908.

There will undoubtedly be an abundance of larvæ in the pools during the early part of 1909; but unless we have a duplication of 1908 weather conditions these will be so generally killed off that the surviving adults will not be offensively obtrusive.

RARITAN TOWNSHIP (Monmouth Co.)

In this township there are 872 acres of marsh along the shores of Luppatcong, Chingorora, Flat, Thorn's and Waycake Creeks. This, it was determined, would require 90,000 feet of ditching and the contract for the work was awarded to Mr. Jesse P. Manahan for $1,600.00.

Work began about July 20th, and was completed by September 1st. The meadows were curiously different in character and quite a modification of our original plans became necessary when this was discovered. Part of what is now salt marsh was originally a sea beach, and at a depth of from 20 to 24 inches a bottom of hard sand and gravel was met with. Below this it was practically impossible to go, and as our outlets were no deeper, this became the depth of the ditches. The surmounting turf layer was entirely porous, however, and drainage is perfect.

Other parts of the meadow were very soft and low, and it was necessary to improve some old water courses before we could get a sufficient outlet for our ditches. The tendency of a marsh to decay at its junction with the upland was well illustrated in some of these places where it was necessary to get down 4 feet or more to tide water at the edge of the creek.

MATAWAN TOWNSHIP.

Proceedings in this township were begun by the service of papers on May 6th, but the local board of health for a variety of reasons took no action until after the beginning of July, and not until after the middle of August were preliminaries completed so that the contract could be awarded.

The marsh area in this township lies along the shores of Whale and Matawan Creeks, covers an area of 612 acres including 60 in the Borough of Matawan and required 87,200 feet of ditching, including 5,200 in the borough.

The contract was awarded to Mr. Jesse P. Manahan for $1,500 and work was begun on August 21st, two machines and several hand gangs being employed. No unusual obstacles were encountered and the contract was completed September 25th. It became necessary, to secure satisfactory drainage in some places to cut up the meadow more than we usually like to do; but the owners made no objections and rather facilitated our work to the best of their ability. On some of these small areas running along creeks, the marsh is irregular in surface and straightaway ditching is not entirely satisfactory. It becomes necessary then to run the ditches along the natural depressions, and to put in occasional cross ditches to relieve bad spots.

KEYPORT.

The town of Keyport has about 150 acres of marsh land on which mosquitoes bred persistently throughout the season and, while it was not nearly so bad as some of the other areas included in our work, its location directly in the town made it a first class nuisance.

It was estimated that this area would require 19,000 feet of ditches and the necessary notices were served May 6th. The local authorities acted in due course and work was begun June 17th and completed June 26th at a cost of $315.00. The work offered no difficulties and was all done by hand.

MIDDLETOWN TOWNSHIP.

A small section of marsh in this township near Atlantic Highlands was drained in 1907 and is referred to in the report for that year. The distribution of the marsh in this township is along the shores of a number of Creeks that empty into the Raritan Bay and the work could be conveniently divided up into separate jobs.

An area of 920 acres extends along both sides of Compton's Creek and another of smaller size, and part of that was in process of improvement by the owners, leaving in the adjacent area a very bad breeding territory for which a drainage scheme was prepared late in 1907.

In April 1908, the contract for this work was awarded to Mr. William B. Smith, of Atlantic Highlands, for $900.00, calling for 58,400 feet of ditching and that contract was completed May 13th, without permitting any mosquitoes of the early brood to come to maturity. The work here has added enormously to the value of property which was delayed in its development by the mosquito pest. The money expended by the State will be supplemented many times over by owners and this, of course, added greatly to the taxable values in the township. Camps are now established at the edge of the meadow which in previous seasons was simply uninhabitable.

Along Pews Creek there was a smaller area of 320 acres requiring 25,700 feet of ditching and the contract for this was awarded to Mr. Jesse P. Manahan, for $498.00. Work was begun early in May and was completed about the middle of June not before a partial brood emerged on the marsh. During the work in May the pools were literally black with larvæ and millions of them were run off into the Bay through the ditches, to be devoured by the killie-fish. Other millions were left at the bottoms of the drained pools so as to blacken them. It was impossible to get over the entire meadow before the larvæ reached maturity, and so part of the brood got upon the wing.

There were no unusual conditions on these meadows and some of the work was done by machine and some by hand ditching. Drainage was rapid and complete in all cases and the ditches were placed so as not to interfere more than absolutely necessary with the use of the meadows for hay crops.

Bedford, Port Monmouth and the Atlantic Highlands are the communities more directly benefitted by the work in this township.

SHREWSBURY RIVER.

This is perhaps the only marsh area which produced no mosquito brood during the summer of 1908. Mr. Grossbeck spent two days on the meadow in June, getting over every portion of it and found absolutely no mosquitoes. He was informed by residents that there was no brood in May, and the appearance of the meadow bears out this report.

Samples of sod taken from what used to be the worst breeding sections showed an almost total absence of mosquito eggs.

The meadows on both sides of the river are looked after by men employed by local associations, the main difficulty being the obstruction of the mouths of the ditches with sea-weed.

MADISON TOWNSHIP.

This contains 1,693 acres of marsh land along Marquis and Cheesequake Creeks. The former is a small stream with an area of only 80 acres on its shores, the latter is a large stream navigable for small steamers for a mile or more, almost to the edge of the highland. The larger meadow is variable in character, part of it very nice and level, part of it a mere succession of holes requiring constant care to prevent falls. The bulk of the area is mud covered, attractive to mosquitoes as places for oviposition and no worse place as a supply existed in the State. From it the Amboys are stocked on a south wind, New Brunswick gets its share on an easterly breeze and on a westerly blow the upland sections to Atlantic Highlands and beyond are supplied with an addition to their local output.

Both Messrs. Brehme and Grossbeck declared that they had never seen more intensive breeding than occurred on this meadow and in early April the pools were already filled with the first brood. By the middle of May there had been two broods of *C. cantator* and one of *sollicitans* and the woods and uplands round about were almost uninhabitable. These broods which developed unchecked were those that were killed off on the marshes that had been drained further north, and for this the work should have credit, for it was not until afterward that the combination of rains and tides became irresistible.

The drainage scheme prepared for this territory showed that it would require 209,000 feet of ditching to clean this meadow and the contract for the work was awarded to Mr. Jesse P. Manahan for $3,100.00. The Marquis Creek area was done by hand and required a few days only. On the Cheesequake Creek

two machines and several gangs with ditching spades were pu work during the early days of July and from the start all sort unexpected obstacles were encountered. The terrific heat intolerable mosquito pest prostrated several men almost at beginning, and Mr. Brehme himself barely escaped prostrati Then it was found that toward the highland where the start made, there was a layer of hard sand and clay below the which made machine work very slow until its edge was pass Soon after the middle of July another enormous brood of m quitoes developed on those parts of the meadow not yet drair For several days every ditch had carried thousands of wrigg and pupæ into the creek, and every pool as it drained showe squirming wriggling mass of life that soon dried out under burning sun; but what was thus destroyed was a mere patch u the huge expanse yet before us. This brood left the meac almost in a body so that in a few days the marsh was comforte while the surrounding woods and upland were filled with adults; all of them *sollicitans*. Then came a stretch of meac so water-logged and broken that it was almost impossible to out an entire sod. It was a veritable honey comb and again p gress was slow because both men and machines were in const danger of miring. A series of high tides beginning on the 2 refilled all the pools with fresh water and almost immedia they became stocked with baby wrigglers. On the drained a 80% of the pools were dry when the tide went down and balance drained off clean before the larvæ were half grown. very rotten character of this part of the territory was an adv tage because it allowed the water to run off readily into ditches which here were generally 200 feet apart.

Early in August it was found that there were other thi below the sod than sand and clay. Logs and old ties were str and an encounter with one of the latter put one of the machi temporarily out of service.

The full moon tides about August 10th again refilled the pc but with it came plenty of killies that kept most of them free larvæ. The larvæ of July 26th had matured a few days bef and were safely out of the way. August 13th pools without were again filled with wrigglers. These emerged a few d later and, when on August 31st I went over the territory w Messrs. Brehme, Grossbeck and Manahan, there was yet anot brood in the few remaining pools near the upper end of meadow. From that time until September 11th when the w was finally completed the meadow was systematically covered Mr. Brehme and the workmen and every depression that still h

water was either filled with sods or connected by a spur with the nearest ditch. In the way of spurs and short ditches over 2,000 feet were put in and, altogether there were nearer to 215,000 feet all told than to the required 209,000.

This is, I believe one of the most effective pieces of work done during the year, and its story has been told in some detail, partly because of its extent and partly because it brings out strikingly the number of broods that develops on a meadow of this kind. Also because it shows how little rain or drought affects such a meadow, and because it illustrates some of the difficulties met with.

The contractor made no money on this contract.

BRICK TOWNSHIP.

Brick Township is in Ocean County and extends from the Manasquan River south to Kettle Creek. Several Boroughs have been taken out of it on the shore, and the salt marsh extends from Bay Head along the west shore of Barnegat Bay to Kettle Creek and on the east shore of the Bay to the point opposite Kettle Creek:—about half way between Montoloking and Chadwicks. This gives a distance of nearly five miles in a direct line and over six miles of actual shore line. It includes an area of 1536 acres and a considerable variety of territory.

The situation at the head of Barnegat Bay is a decidedly peculiar one owing to the closing of the northern connection with the ocean. This has resulted in freshening the upper end of the Bay by the waters of numerous streams that pour into it and the original salt marsh has freshened and begun to decay. The vegetation peculiar to the salt marsh has almost entirely disappeared at Bay Head and for two or three miles along the western shore. On the eastern shore conditions are somewhat different and just north of Montoloking there is a broad marsh that is salt to all intents and purposes, especially as to its mosquito breeding abilities. Not until we get well along toward Kettle Creek on the west shore does the water get decidedly brackish and the marsh vegetation obtain a characteristic salt appearance. Owing to the distance from Barnegat Inlet there are no decided tides at Bay Head, a rise and fall of six or eight inches measuring the normal variation. A heavy north or northeast wind, however, may drive the water down the bay so as to lower it a foot or more and, on the other hand, a southerly wind may drive up woter enough to overflow the low meadows for a long distance. Cran-

berries grow here to the very bay edge and are not infrequent covered by its waters.

This condition of affairs caused a very material increase in tl difficulty of our drainage work. The bay is very shallow at tl shore for most points and made so poor an outlet for ditches th we were compelled to run into Creeks so far as possible. And our ditches could not be made much deeper than the outlet wit out danger of letting the bay water in rather than drawing tl surface water out, some of our ditches are not so deep as v would have preferred to make them.

Service of papers was made upon the local authorities Ju 25th; but through continuous delays and postponements t necessary action was not taken until the end of August. By tl time bids had been advertised the end of September was near a the contract was awarded on the 14th of that month to Mr. Jes P. Manahan for $2,600.00, calling for 180,000 feet of ditche September 29th three machines were in the field and sever spade gangs were at work in Bay Head and its immedia vicinity. The original peat at this point had rotted down almo completely into a black decomposed mass and this was not ide material for permanent ditches. But matters improved as we g south of the Metedeconk River and there a good turf body w secured. On the shore side there is quite a depression betwe the sand hills and the Pennsylvania Railroad and this was ditch so as to carry the water through the culverts beneath the track the Bay. The marsh at one point near Mantoloking broade out so as to require quite a bit of ditching. The new road ru ning parallel to the railroad near Mantoloking has left so ugly depressions on the eastern side which are undrainable a in which *Culex sylvestris* will probably breed until they beco filled with vegetation.

A decided handicap in this work was the necessity of trar porting the men each day from Bay Head to the point of oper tions, for there are no settlements on the Bay shore available points of supply for provisions, etc., and it was necessary bring engine and spade crews from the City because no lo labor was available. The present gangs have been doing mar work all summer along the coast and are tolerably well season to mosquito attack; when they were forced therefore about t middle of October to knock off work at 4 P. M., because th could no longer stand the mosquito attacks no further statemer concerning their abundance would seem to be necessary. seems probable that a portion of what is now a marsh was at very remote period a wooded area for at several points stump

trunks and logs interfered so much with machine work that the spades were resorted to until better territory was again entered.

The contract was to be completed by the last day of October and the work was practically finished at that time, only a little spurring and filling remaining to be done. This was all done during the first days of November.

LONG BEACH TOWNSHIP.

In the Report for 1907 an account was given of the work done from the Borough of Beach Haven south to the New Inlet and the problem met there was fully described. At the time that action was taken by the Board of Health, it was general in character, and notices were served upon all the owners not only south of Beach Haven, but north of that borough to Barnegat Junction. Jurisdiction had been acquired, therefore, and when the new appropriation became available November 1st specifications were ready and bids were advertised for in accordance with the requirements of the law.

The contract was awarded to Mr. Jesse P. Manahan for $3,600 and work was begun at once with large gangs, the mildness of the season permitting its completion early in January.

As compared with the stretch to the south of Beach Haven, this work was complicated by the seven miles of railroad extending from Beach Haven north to Barnegat Junction and cutting the drainage line from the sand hills to the bay. But the railroad company had provided numerous culverts through its road bed and had placed good ditches on each side for most of the distance. At intervals broad ditches extended from the road to the bay and, in a general way, there was plenty of outlet for most of the surface water. As a whole the distance from ocean to bay is less than it is to the south, and there were not so many marshy depressions among the sand hills which could not be either drained or filled; hence there was no necessity for draining to a centre or for establishing permanent pools in any case. It was a choice in every instance of either ditching or filling. West of the railroad line it was mostly straight marsh work and ditching was easy and effective. East of the railroad line conditions varied and the work done was adapted to the needs of each case.

At Beach Haven itself the ditching that had been done in 1904 was in good condition generally, and the ditches had been cleaned in 1907. In a few places sand had washed in and these places were cleaned out and the system thus restored.

At North Beach Haven there were several bad breeding places most of which it proved possible to drain. There were plenty of culverts through the railroad embankment and from each of these a broad deep main ditch was run to the Bay. Then a deep main ditch was run from the culverts east of the railroad through the centre of the depressed area and from these, branch ditches were run so as to take in all the breeding places. In some cases the ditches were run in between the sand hills so as to make tide water connections into depressions which had only stagnant water areas heretofore. As it stands now there is tide water connection into each of the low areas and fish run up into every hole that is not actually laid dry. In a few small depressions it was deemed best to resort to brush and sand filling. The section west of the railroad was ditched and given outlets into the bay.

Between North Beach Haven and Spray Beach the area east of the railroad was mostly ditched. There were plenty of outlets through the railroad dam, and there was no difficulty in reaching most of the breeding pools. West of the railroad there are several tidal ditches which are always filled with killies and which serve to drain the meadow. The tide frequently comes in over the ditches; but when it does the fish come over also and get into all the pools that are left at the next ebb. Any mosquito larvæ that hatch in such pools have no chance to develop even should the pools last long enough to bring them to maturity.

At Spray Beach conditions were bad. There were several large depressions in which water remained for long periods and where mosquitoes bred in millions. It was impossible to make tide-water connections, and as there was plenty of material about it was decided to fill. One of the areas was so large that it took 16 men 15 hours to do the work and nearly 500 wheelbarrow loads of sand were dumped over the brush foundation filling. When completed these filled areas could not be distinguished from the level land surrounding them, and the character of the fill is such that the water will soak through the surface sand as fast as it comes down. There will be no more mosquitoes bred in these places.

Between Spray Beach and Tucker's there was a bad section east of the railroad where considerable filling had to be done. There were a number of bad depressions among the hills and all of these were brush and sand filled. In a few places where there were culverts through the railroad some ditching could be done and connections were made with tide water. The worst place on this stretch was at Life-saving Station No. 21. To relieve this a wide ditch was cut from the bay to the railroad, the culverts

beneath the road was cleaned and a large main ditch was cut toward the Station. About a dozen spur ditches were required to reach all the danger points; but the surface water has been successfully removed. West of the railroad, ditches were cut wherever necessary and filling was required at only one point in a cow pasture.

Between Tucker's and Peahala the territory east of the track is hilly, with water filled holes and depressions. There were few culverts through the railroad here and filling was done almost exclusively. Only a few ditches were cut where a culvert was convenient to carry off the water and where the lay of the land made it seem expedient. West of the railroad ditching was done wherever it seemed requisite.

Between Pehala and the seaweed house, ditching was generally possible on the east side of the track where there is a considerable stretch of typical salt marsh. There were plenty of culverts through the railroad here, so that no difficulties were met in getting off the water. Nevertheless there were a few places, especially just north of the Pehala Club house where ditching was not possible. One such depression was about 150 feet long, 15 feet wide and 2 feet deep, separated from the ditched area by a low ridge about 25 feet wide and of sand so loose that it would not possibly hold a ditch. This made filling a necessity, and the work was satisfactorily accomplished with brush and sand.

At the seaweed house was a rotten piece of meadow, always more or less water-logged and on which, therefore, no grass would grow. There was a culvert under the railroad and a clogged ditch from that point to the bay. It looked almost impossible to get the water off here, but filling would have been an expensive piece of work, and it was decided to attempt drainage first. The old ditch was first deepened to such a point as to give free outlet for all the water that could get into it from the west side of the road and the culvert was enlarged and cleaned. A main ditch was then opened through the low point of the meadow and the water began to get out with a rush. It was allowed to stand until the surface was so far free as to show where other ditches were needed and these were run as seemed necessary, until the entire meadow was practically laid dry. As conditions stand now this area will grow up in grass and become productive. West of the track conditions were such that the ditching machine could do the bulk of the work, and ditches, 10x27 inches were cut about 200 feet apart, with spur ditches wherever they were needed to take the water off more rapidly.

Between the seaweed house and Life-saving Station No. 20

ditching was possible on the east side of the track and there w culverts enough to carry off nearly all the water. Only a f small fillings were required. West of the track machine w was continued along the lines already described.

Between Life-saving Station No. 20 and the Junction, b ditching and filling were required east of the railroad. This v rather a complicated territory and some large fillings as well several long ditches were needed to make the meadow safe. W of the railroad ditching was practicable, and good surface dra age has been provided.

At this section of the marsh area along the bay, the turf la is deep enough to hold a 27-inch ditch, and there seems to b mud layer of some depth over the sand. There is also an indi tion that in the not far distant past the entire meadow has b flooded and sand covered, for there is a layer of sand abou inches thick, some ten inches below the present surface of marsh. This is a great help in the drainage, for it furnishe layer through which the water makes its way readily into ditches, and none of the holes on the marsh seem to go below t layer. As a whole a very satisfactory piece of work was acc plished.

In the Spring of 1907 there was some complaint that the s from our ditches had floated over the meadows and ruined th for haying purposes. I sent Mr. Brehme down at once and la went down myself to investigate. As a matter of fact the li of sods lay intact from the upland to Bay just as we had l them, except in a few places done with spades where some the small sods had floated. But this was in sections where hay had ever been cut and the complaints, as it turned out, w based upon an effort to get the hay crop for a smaller sum tl paid to the owners in previous years.

The township appropriated a sufficient sum to go over all ditches and clean the outlets of the seaweed which, in this part the Bay, covers the shore in great quantity.

In order to test the scheme of draining to a centre I sent l Brehme over the entire territory drained in 1907 with instr tions to get assistance and re-stock all pools in which the had perished. It turned out that there were very few such that in some of the larger ones the fish had actually bred. I few places the areas were laid so dry that frogs and turtles l made their way to the pools as a last refuge and had devou the fish. Not all of these places were re-stocked because, parently, the water soaked away rapidly enough through barrel pits. The winter did not in the least injure our work

SALT MARSH IMPROVEMENT.

The investigations made in the latter part of 1907 demonstrated such an enormous improvement in the character of the drained marshes and so marked an increase in the crop harvested, that the facts were brought together in the form of a bulletin and issued as No. 207 of the Agricultural Experiment Stations. That Bulletin should be referred to in connection with this Report.

Some effort was made to learn the extent of the salt hay crop but this could not be fully carried out. Such information as was obtained, however, shows that a very small part of the area produces as great a crop as it should, and that what is produced does not bring as good a price as its merits warrant.

The outlet for salt hay is by no means a large one at present, and altogether too unreliable to warrant a large increase in the production. This is partly due to the character of the crop itself and partly to the uses to which it is put. As conditions are now the hay crop depends altogether on the season; sometimes it is good, sometimes it is poor and the price varies according to the size of the harvest. The uses for salt hay are largely as packing and the amount in demand depends upon business conditions. In 1907 there was a very large crop of hay, coincident with a business depression that reduced demand to a minimum, and a consequent low price:—so low as to scarcely repay harvesting and handling.

But this salt hay is altogether too valuable to be wasted for packing material alone and could a sufficient crop be relied upon annually it could and would be used to supplement the more expensive upland hay in feeding horses and cattle, for its nutritive value is high. This is a point that will be further elaborated at the Station, with the view of increasing demand and providing an outlet for the material.

It is expected that the ditching work now in progress will demonstrate that by properly regulating the water supply on the marshes annual crops may be depended upon, and that by supplementing the drainage work done under the mosquito law, the meadows can be put into such shape that they will increase the amount produced without increase of cost except in harvesting.

On July 21st, I had an opportunity of seeing, at Stratford, Connecticut, an area of some 1,500 acres of salt marsh, drained and partly dyked and reclaimed by Mr. Frank R. Sammis. The largest part of the acreage is devoted to raising salt hay of the best quality, and Mr. Sammis has secured an outlet at good prices

for every ton that he can get. On the dyked marsh a section of some 100 acres had been kept free from salt water since 1904. On this territory strawberry, asparagus, onions and celery were being raised, and while the asparagus left much to be desired and the strawberry plants were not extraordinary in any way, the onions and celery could not be excelled. In fact so good were the celery plants that most of the market gardners obtained their supply of them there.

There are many hundreds of acres along the shores of Barnegat Bay, and especially along its upper portion where a very small amount of dyking will serve to keep out salt water and fit the land for certain truck crops.

It has also developed that along a large portion of the Barnegat Bay line cranberry plants grow naturally to the very edge of the salt marsh line; but these could not be improved because there was no way out across the marsh for surface water. The work now carried on will make this land available, in large part at least, and will give opportunity of deriving a revenue from territory which is now practically non-productive to the owner and to the townships in which it lies.

MONTCLAIR HEIGHTS.

Early in the Spring I was requested by the committee from the State Board of Education having in charge the construction of the New Normal School to inspect the swampy areas near by on State property, to determine whether or not they were dangerous as mosquito breeding places.

Inspections were made in early April and it was found that there was a danger point in which not only the ordinary pool mosquitoes but the *Anopheles* species could develop.

No money being available for drainage work out of the school funds, it was determined to apply $250.00 out of the mosquito fund to clean out this territory and the work was done before the end of May. Altogether about 3,000 feet of ditching was placed or improved and all the surface water drawn to a culvert through the Railroad embankment. The heavy rains of May gave excellent opportunity for testing the effectiveness of the work done and it fully approved itself. No mosquito breeding was found there at any time during the season.

The ditches put in here were much wider and shallower than those put into the salt marshes and will work as depressions along natural lines even if they become partly grown up. Eventually

this swampy area should be filled, since it depends for its outlet altogether upon the Erie Railroad.

ESSEX COUNTY PARKS.

In past years the territory embraced in the Essex County Parks on the South Orange Mountain has been more or less responsible for certain species of woodland mosquitoes. This fact was fully appreciated by the Commission and its Secretary who were in communication with this office and requested suggestions.

These were given at a meeting on the territory in the fall of 1907, as mentioned in last year's report. The result of this conference was that during the winter and early spring of 1908 the entire Park area was gone over and almost or quite every breeding pool was either drained or filled. Every water course was improved, several thousand feet of ditches were put in and a number of swamp areas not easily drainable were filled in. Mr. Brehme went over the territory carefully in April, spending parts of three days in the park area, and he reports not a single larva developing in the jurisdiction, though a few bad places exist just outside.

The Commission deserves the highest praise for the thoroughness with which the work was done and also for the manner in which they have looked after the catch-basins in park areas under their control. Whenever examined during the summer they were always found oil-covered and mosquito free. If mosquitoes occurred in the County Parks they were not bred on its territory. A considerable sum of money was spent in the work and it was well spent.

ORANGE MOUNTAIN REGION.

In the village of South Orange the mosquito work has been continued as usual and on the whole successfully, the weather conditions of May influencing conditions there as elsewhere. On a larva hunt in April and May, Mr. Brehme reported oil on every pool and even beyond the limits some bad breeding places were treated.

In the direction of Millburn and Short Hills a number of the owners had improved their own territory by some drainage and a little filling; but not all the work was well done and the proportion of actual breeding territory improved is rather small. The woodland here is almost continuous, so that mosquitoes breeding

in one section would have nothing to prevent their getting to others without crossing large open areas. On the whole the woodland mosquitoes were not so abundant as they were in 1907, and they disappeared much earlier in the season. In late summer *C. pipiens* was most in evidence and was generally bred in the immediate vicinity of the dwellings.

Other communities in this region had the same experiences: an absence of the usual flights of salt marsh species early in the season and an abnormal increase of the local variety by mid-summer and later. In some places where matters are usually very comfortable, the conditions were worse than they have ever been known to be and nothing was done to better them.

RIDGEFIELD BOROUGH.

Early in July I received a request from the Board of Health of Ridgefield Borough, that they be given information as to how the mosquito pest then becoming troublesome could be dealt with. In compliance with this request I sent Mr. Grossbeck to investigate and as his report of conditions found July 20th and 21st is rather typical of the general region, an abstract is here given.

He found among the species present, *Culex sollicitans* a salt marsh breeder. *C. perturbans* a typical swamp breeder and migrant, *C. sylvestris* a pool and swamp species and *C. pipiens,* the common house mosquito.

C. sollicitans is a migrant from the Bronx district, New York City. On that point there seems to be no reasonable doubt. The breeding places of *C. perturbans* were not located and no likely places were found in the borough. Both these species were in the minority.

There is a sewerage system in Ridgefield, but it does not cover the entire settlement and there are many cesspools and a number of road-ditches which are practically open sewers. Almost every cesspool examined was swarming with larvæ and pupæ and in the eastern part of the borough many of the sewers were in bad condition, partly grown up and full of wriggler life. These two factors alone accounted for most of the house trouble. Sewer catch basins were also breeders.

There is a public water supply and it was said that there were neither cisterns nor rainbarrels in use in the borough.

In the rear of a barn near the railroad station a drainage pool was found with thousands of larvæ. A sluggish ditch beginning at the station and extending northward on its east side contained pupæ and many egg-boats. South of the station was a good

ditch free from larvæ and requiring no attention. Along th east side of the railroad, north of the station, was an enclose water area in which *Anopheles* or malaria carrier larvæ wer found. A stretch of low meadow along Wolf Creek was dar gerous as a breeder of *C. sylvestris* and of *Anopheles;* but cap able of easy drainage into the creek.

From an indoor examination the specimens were found to b *C. pipiens* exclusively, and mostly of the small variety that i capable of getting through the meshes of wire screens.

Here is a case where the remedy for local troubles is ver simple and entirely within the province of the local board o health. It means tight cesspools and clean gutters chiefly, wit a little attention to local surface drainage. The majority of th villages and towns now building so rapidly along this line o country has exactly the same conditions to deal with.

TRENTON.

Conditions in the City of Trenton have improved materiall as compared with those first reported upon a few years ago. A the result of the campaign begun by the board of health an quietly but persistently carried on, by far the worst condition have been completely eliminated. The ugly swamp area back o the State House and along the shores of the Delaware River ha been mostly filled and a portion of it is in process of improvemen to form a park—a purpose for which the site is eminently fitte

By a circular letter to manufacturers the board called attentio to those local conditions which favored the development of th mosquito pest and suggested methods to abate them. Very gen eral heed was given to this circular and a surprisingly large num ber of breeding places were gotten rid of by using ashes or othe available filling material.

The City is by no means clean as yet; but the remaining troubl requires larger treatment and will be helped by additional sewers Sewer construction by the bye has been an extremely importan ally in the work, since it has furnished a method of getting rid o much dangerous waste. On a trip through the City in Octobe with a committee of the board of health, the improvement in con ditions was markedly apparent.

The "White City" conditions referred to in the last repor under the head of *Culex perturbans* proved so serious a draw back to the success of the resort that the manager professed readi ness to do whatever was necessary to get rid of the pest. Sug gestions were therefore made for the drainage of the breeding

area and work was begun April 16th, when Mr. Grossbeck found larvæ still generally present where they were collected the preceding fall. The heavy rainfall in early May raised the River to such an extent that the water flowed into the swamp from it instead of the reverses and that, of course, stopped all work. With the falling of the River the effect of the drains became more evident, and by early June almost all the water was off and very few larvæ and pupæ could be found. June 10th neither larvæ nor pupæ were obtainable, but some adults had already emerged and a few were taken.

The practical result of the work was that while the mosquitoes were by no means absent, they were not present in disturbing numbers and had no apparent effect upon the patronage of the resort. The work as it was done, however, is not satisfactory and a mere makeshift. While the brood for 1908 was mostly killed off the drainage is not sufficiently thorough to bar the re-establishment of the species and the shallow ditches made through soft mud have become almost obliterated. There is a natural channel through the swamp and it means deepening this and if necessary the creek that connects it with the River. It will cost a little to do it but the results are certain.

MISCELLANEOUS INSPECTION.

Inspections were made in a number of localities other than those specifically reported upon, sometimes informally, in company with some resident or member of the local board of health sometimes independently to secure information enabling me to answer questions asked.

Among those in which formal reports were made were Metuchen, Merchantville and Lyons Farms; but neither offered anything at all unusual or peculiar. In a general way it may be said that away from the influence of the migratory forms, local natural conditions throughout the State are rather good, and it is the artificial and incidental pools that produce the greatest amount of trouble. Cess-pools, cisterns, rainbarrels, gutters, sewer basins and sewage pools are the more usual sources of supply and in most cases readily brought under control.

THE HOUSE MOSQUITO.

The season of 1908 was eminently one favorable to this pest, and so abundant were they in our larger cities that the benefits

derived from the absence of the salt marsh mosquitoes were not fully appreciated.

The conditions that produced this state of affairs are easily enough understood but could not have been anticipated or guarded against.

April came in warm and pleasant and this continued in early May, bringing the hibernating specimens from their winter quarters earlier than usual. There was plenty of rain to make pools, and no trouble for the early crop to find breeding places. And then came the phenomenal precipitation of May which filled every low marshy area and created a supply of surface water that lasted until the end of June. This will be better understood by the following table:

City.	Rainfall.	Normal.	Excess in '08.
Jersey City	9.09 inches	3.18 inches	5.91
Newark	9.01 "	3.92 "	5.09
Elizabeth	8.00 "	3.86 "	4.14

Then came the warm weather of early June and the ideal conditions for mosquito development were completed. The importance of all this was not realized at the time or a vigorous campaign in the cities might have headed off trouble; but by the end of June and early in July when the surface water had practically disappeared there was a terrific supply of mosquitoes for that time of the year, all looking for breeding places. And now the sewer catch basins from which evaporation was slow, came into play. What little rain fell kept these full, and brood after brood emerged until early in August conditions became serious not only in some New Jersey cities but throughout greater New York, Philadelphia and elsewhere. The midsummer brood of small specimens that work their way through the screens was especially vicious and abundant, and not an available breeding place remained undiscovered. Tin cans in dumps, lot pools, cisterns, cess-pools, manure pits, vats, storage tanks, every receptacle that would hold water, indoors or out was likely to be found swarming with wrigglers and to give rise to hungry adults. It was a combination with which none of the organizations were quite ready to deal, and even in well organized cities like Jersey City, Newark and Elizabeth there was trouble, while in many smaller towns and villages the situation was abandoned as hopeless.

A similar combination is not likely to occur again for many years; but it has emphasized the importane of early work in city and town campaigns. The work really should begin in winter in the cellars to kill off the hibernating females; because with them

the source of later supply is cut off. What this means may be estimated when we know that each female lays 200 eggs producing 100 pair which in turn produce 10,000 pair, all within one month! What the estimate would be figured out to the end of the season any one with mathematical tastes can work out, allowing two weeks from the egg to the reproductive stage.

This subject was considered so important that a Bulletin was prepared for publication to be issued in December, 1908.

MR. BRAKELEY'S NOTES ON PERTURBANS.

In the report for 1907 Mr. Grossbeck records finding the eggboats of *Culex perturbans* at Lahaway, July 31st and that, later, Mr. Brakeley's collections in the pool where the eggs were found, gave us the first real clue to the habits of the wrigglers, so that we were enabled later to collect them in some numbers near Trenton. Larvæ were found up to November, 1907, and the conclusion that they hibernated in that stage seemed irresistible. Mr Brakeley in his efforts to determine this point definitely, began observations in midwinter, noting that the pool known to contain larvæ was covered with 9 inch ice January 24th, '08.

February 20th the pool was still ice-covered except over a small spring hole, and from the bottom here a sample of mud and vegetable material was gathered and examined without definite result. The question to be determined was whether the larvæ present buried themselves in the mud or whether they remained attached to the roots of the floating vegetation and froze solid with it.

March 7th, the first *canadensis* larvæ were noted, evidently just hatched, the *perturbans* pool was free of surface ice, but the floating sud or vegetation was still frozen solid to a distance from 3 to 4 feet from shore. Reaching in under this frozen mass several large handfulls of roots were torn from it and examined. Six larvæ were washed out, all well grown, evidently attached to the roots and demonstrating that they shared the fate of the roots, remaining in the icy mass whenever there was freeze and thawing out with the vegetation itself. There had been no growth over that noted the fall preceding.

Collections were also made April 7th and 12th, and on the latter date the larvæ were active and from the appearance of the intestinal canal had begun to feed. Collections made elsewhere on the place gave negative results. Obviously the insects require characteristic conditions which include proper vegetation, pe

manent water supply and a practical absence of predatory aquatic life.

During May collections were continued, masses of the sud or floating vegetation being pulled each time and examined in basins or pails of water. The first full grown larva was found May 17th, and on the 28th, 3 pupæ and 12 larvæ in various stages of growth were collected. On the 31st, from a bunch of grass pulled out of the pool with adherent mud, took 6 additional pupæ. The first adult, a ♂, emerged June 1st. Additional collections during the early days of June turned out added pupæ and full grown larvæ, a very few adults being obtained from the pupæ. No pupæ were at any time taken from the surface of the pool nor were any empty pupa skins seen floating on it. In fact so far as surface collections would indicate the pool was totally bare of mosquito life. Mr. Brakeley also noted in this connection that unless an adult issued from a pupa within 56 hours after collection, the pupa died and few pupæ survived 48 hours.

The breathing tubes when the pupa rested at the surface were held close together, so that the tips formed a single point; but each tube is capable of independent motion and sometimes the pupa seemed to use one as a pivot and turned round with the other extended as far out as possible, apparently exploring the vicinity. He also notes that this is the only mosquito pupa that is heavier than water, requiring a distinct effort to rise from the bottom to the surface, whereas in all other species the pupa rises to the surface without effort; but requires a distinct effort to get to the bottom. The conclusion is that the pupa never voluntarily comes to the top in a state of nature; but that the adult emerges under water and pops up to the surface upon which it rests for a few moments to harden, before it is ready to fly away. June 13th, one adult not yet hardened was taken from the surface of a pan of water containing root masses for examination and no pupa skin was found at the time from which it could have emerged; but later in washing out the material, a pupa skin was found. So on June 29th an empty pupa shell was washed out of a mass of bottom material from which larvæ and pupæ are normally taken.

Collections were made at short intervals throughout June, and larvæ and pupæ were found continuously, some of the larvæ beneath vegetation that was covered by 12 inches of water, and on the 19th a larva was found not more than half grown.

Meanwhile, soon after pupæ were found and the first adults were bred early in June, specimens were found in nature, in ever-increasing abundance and became more or less conspicuous and

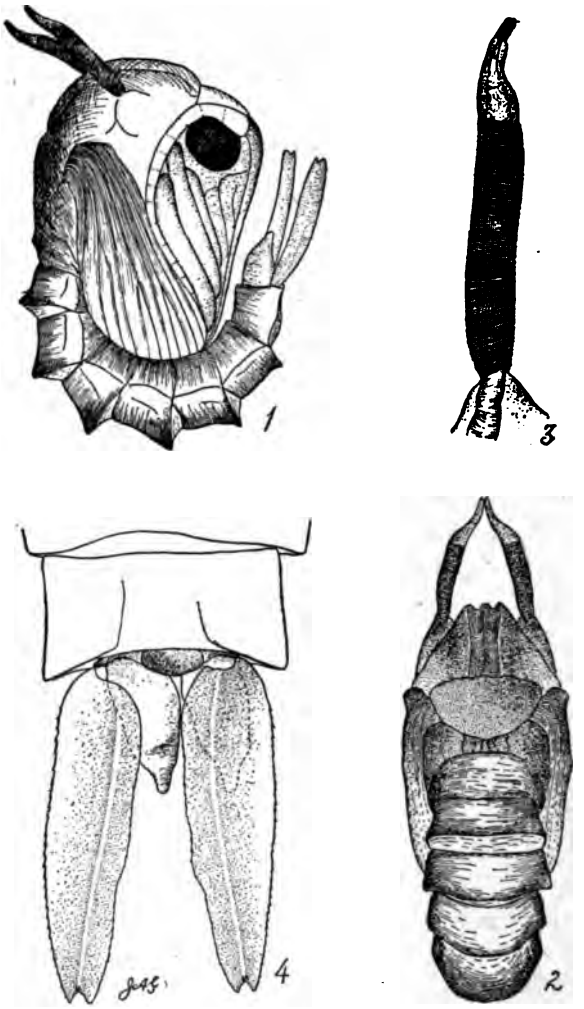
annoying indoors. This induced Mr. Brakeley to include a look-out for egg-boats in his collecting scheme, and the first of these he found June 28th, over a month earlier than our 1907 record and fully three weeks after the insects first appeared on the wing. And just four days previously larvæ only half-grown had been taken! June 29th, other egg-boats were found and young larvæ were obtained from some of these July 1st, at which date almost every stage in the life cycle of the species could have been collected from this one pool. That condition continued until the last day of July, at which time there were still larvæ of 1907 in the 4th stage, and larvæ of 1908 already at the end of the 2nd stage, while new egg-boats were on the surface and fresh adults were seeking their first meal.

Mr. Brakeley's observations thus fill practically one entire year and demonstrate; 1st, there is only one brood during the year: 2d, the larvæ hibernate and remain attached to their root mass even when this freezes solid: 3rd, the pupa does not normally come to the surface at any time: 4th, egg-laying begins while yet a large percentage of the previous season's larvæ are undeveloped: 5th, adults begin to appear early in June, continue to develop until early August and stragglers remain in noticeable numbers until early September.

Mr. Brakeley's collections of egg-boats emphasize some of the points made by Mr. Grossbeck in 1907, and bring out even more strongly the tendency to attach themselves to a blade of grass or other vegetation until the boat stands almost upright against it. So the requirement of a shaded area is brought out, and explains why other areas at Lahaway, apparently similar in character, nevertheless produce no wrigglers.

The season of 1908 was not, on the whole, so productive in adults as 1907. After they once began to appear there were almost always specimens to be found; but they were not present in the swarms that characterized 1907.

Mr. Brakeley also believes, and in this I think him correct, that the known breeding area at Lahaway does not account for all the adults found on the place. Yet there is no similar area for a considerable distance. Mr. Brakeley knows the territory well and has found the adults more than a mile away from home; but no place to correspond enough with the *perturbans* pool on his own place to make him feel certain that the insects breed there. It seems probable, therefore, that they come in from some areas a considerable distance away and while not to be considered migrants like *sollicitans* or *cantator,* are yet wanderers over a considerable area.



Pupa of *Culex perturbans* and details of structure: **Original.**

It seems also probable, from Mr. Brakeley's observations, that the percentage of mortality among the larvæ is very great. The *perturbans* pool at Lahaway covers only 3,150 square feet of area and of this less than 1,000 feet is suitable for breeding purposes. Yet in that area Mr. Grossbeck found 60 egg-boats in two days late in the summer and that is probably not 5 per cent. of all that were deposited during the season. At only 200 eggs per boat, that would make the wriggler population run into the hundreds of thousands and yet with all his collecting in the season of 1908, Mr. Brakeley took less than 200 larvæ and less than 100 pupæ! He did not, of course, overhaul the entire breeding area; but he did sample every part of it and there was none that averaged up to what the most modest probabilities called for. In fact, in this confined pool where egg boats by the hundred are deposited the larval collections were far inferior in extent to the collections made by Mr. Grossbeck at Trenton, collecting also in a much less thorough manner.

THE MOSQUITOES OF THE SEASON

WITH NOTES ON THE EGGS FOUND ON THE SALT MARSH.*

The mosquitoes of New Jersey and their life histories in general are now sufficiently well known for practical purposes and, partly for this reason, little attention has been given to that study during the past season. To ascertain the complete life cycle of many of the species from egg to adult, much yet remains to be done; but the work of the office and in the field of drainage operations and inspection has demanded all the available time.

Records were kept, however, of the species noticed or collected, and these have served as the basis for the following notes.

Anopheles. Species of *Anopheles* were met with on only a few occasions: *punctipennis* in the larval stage at Trenton and Ridgefield, *maculipennis* as an adult in Trenton, and pupæ of *Anopheles barberi* were taken in a tree-hole at Chester, August 16th. From the latter several male adults were secured.

Culex cantator. Though the larva of this species never occurs off the salt marsh it nevertheless prefers the fresher waters. In the northern half of the State it usually comprises the whole of the early brood, and is then found over all parts of the meadow.

*This paper has been prepared by Mr. J. A. Grossbeck, who is in charge of the Laboratory work of the investigation.

But at that time the water is largely fresh from the melting snow and frequent showers. As the summer progresses it is supplanted by *Culex sollicitans* and, if found at all, it will be on the areas bordering rivers close to the point where the salt marsh merges into the fresh water reed and cat-tail areas. In early fall it reappears in association with *sollicitans* and in the latter part of that season is often the predominating form on the northern marshes.

Comparatively little was seen of this species north of the Raritan River, since the early spring brood was completely killed off soon after hatching, as a result of the ditching done the year previous. South of this point, where drainage was not begun until 1908, an immense brood emerged; that of the Cheesequake Creek area dispersing over the country in a northerly and westerly direction for many miles. There was practically no fall brood.

Culex sollicitans made its appearance in the northern section of the State as the first brood of *cantator* was disappearing. Many millions of larvæ hatched on the drained meadows and would have shared the fate of the *cantator* brood but for the unusual combination of incessant rains and constant east winds resulting in continuous high tides—which permitted the larvæ in some cases to reach maturity. The adults spread over the adjacent country and caused some little annoyance; but even as it was only an exceedingly small proportion of the entire brood developed. Later in the season they disappeared from the drained areas.

Culex taeniorhynchus continues as rather a rare species in New Jersey; only a few specimens having been taken on the Cheesequake and Matawan Creek areas in 1908. In New York State, however, on the marshes along Westchester Creek, the whole of a mid-summer brood was composed of them. Like *sollicitans* this species leaves the meadow soon after emergence from the pupa and causes great annoyance in the districts it infests.

Culex perturbans. In 1907 the method of egg-laying and habits of the larva of this species were worked out but on account of the hibernation of the latter the pupa remained unknown. Early in March, 1908, a large number of larvæ were collected at Trenton and brought into the laboratory so that the act of pupation might be observed and the length of the pupal period determined. The larvæ were placed in a jar, but separated from their vegetable attachments they showed an evident disposition to rise to the surface, there to become sluggish and finally die. Single

strands of roots or even small bits of sod taken from the swamp were ignored, so ultimately they were provided with an entire grass tussock taken from the swamp in which the larvæ were collected. They soon disappeared into this and nothing more was seen of them until on May 20th, two dead male adults still attached by their feet to the pupal skins were on the surface of the water.

The sod was now removed from the jar for examination and four living and two dead larvæ were taken from the vegetable mass; also two living and one dead pupa. The two living pupæ were transferred to clean water and unlike other *Culex* pupæ immediately sank to the bottom; aside from an occasional flap of the anal paddles showing no signs of life. For three days the pupæ remained in this death-like attitude and were then placed in alcohol, supposedly dead.

In general build and appearance the pupa (Fig. 1 and 2) resembles the normal *Culex* type, but a strikingly characteristic feature is found in the long, slender air tubes which converge apically and finally meet at a common apex. In color it is light brownish, with the head and thorax, except those portions inclosing the metanotum and eyes, soiled whitish. The length of the thorax is about 2.5 mm. and including the extended abdomen, which is unusually long, about 7 mm. The air tubes (Fig. 1, 3,) measures 1 mm. in length or slightly over, are strongly infuscated and finely ringed for over two-thirds the length from the base and each is suddenly constricted toward the tip, conforming in this respect with the air tube of the larva and evidently for a similar purpose. The entire pupa is destitute of external vestiture except for two small hairs situated near the base of the second abdominal segment. The anal paddles (Fig. 1, 4,) are about four times as long as broad, and have finely serrated margins.

On June 2nd, the first pupa was collected in the Trenton swamp and on the 5th two others were taken. They were washed from the bottom mud and vegetable debris and like those in the laboratory showed scarcely any signs of life. They gradually died without producing adults. By this time the water in that portion of the swamp which supplied us with larvæ was so completely run off in consequence of drainage operations that further observations in this place were precluded. Mr. J. T. Brakeley, of Lahaway, however, was able to continue his studies throughout the season and his observations will be found on another page.

From what has been observed it is certain that the pupæ never

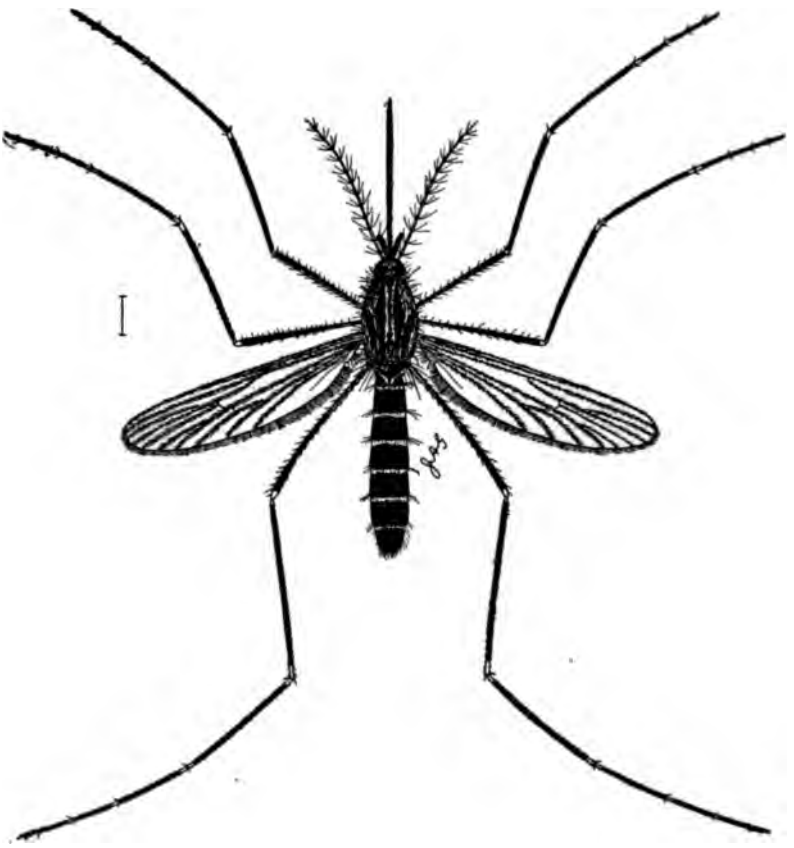
come to the surface for air as do the other forms of *Culex* of which the early stages are known. It is almost equally certain that the air tubes used in unity are inserted into the grass roots and as with the larva oxygen is secured through the tissues of the plant. That these tubes are not permanently fixed in one position is shown by the fact that they separate when immersed in alcohol.

Culex subcantans still holds its record as a locally and seasonally common mosquito. It occurred in the spring of 1908 in many of the woodland pools in the Great Piece Meadows; but save in one instance, in only very small numbers. The exceptional pool contained countless myriads of larvæ and pupæ associated with no other species. This pool is interesting from the fact that at the same period in 1907 it contained only the larvæ of *abfitchii*; in 1906 those of *pretans,* and in 1905 those of *canadensis*—all normally one brooded species. In all cases the pool, the dimensions of which are about fifteen feet wide by some forty feet in length, was densely populated around the edges for a distance of two feet out and a scattering was present even to the center. It is not over twelve inches in depth at any point and the bottom is hard and clayey with a covering of old leaves. It contains very little insect life aside from Ephemerid larvæ; and even tad-pools are absent from it as far as observations go. Just what conditions produce this anomalous result can hardly be surmised though it seems possible that the eggs of the various species lie over for a number of years; if this be the case sooner or later we may expect to find again a brood composed of all *canadensis.*

Culex abfitchii was not so abundant as in 1907, though it was taken in small numbers in several places in the mountainous regions of the State.

Culex canadensis. This, the commonest and most widely distributed of our woodland mosquitoes was unusually scarce. *Canadensis* occurs normally in almost every transient woodland pool over twelve inches in diameter; but in 1908 not more than four or five, and in some cases, not more than one or two per cent. had any, and if some were present they numbered not more than a few score at most.

Culex dyari Coq. A single female specimen of this handsome species was bred from a pupa collected in the swamp at the north end of Culver's Lake, Warren County, on May 28th. It was found at the base of a grass tussock in a typical *Culex aurifer* breeding place, scores of adults of the latter species being present at the time. It appears that the larval period for *dyari*



Culex dyari: new to the New Jersey funa. **Original.**

was also past, as persistent fishing did not reveal even a second example. The pupa hatched on the following day, May 29th.

Culex dyari (Fig. 2) may be separated from all other species occurring in New Jersey by the peculiar golden streaked appearance of the thorax and by the banding of the legs which, like *canadensis,* have the tarsal joints white at each end, though much less distinct than in that species.

DETAILED DESCRIPTION OF THE ADULT.

Female.—Measures 5 mm., = .20 inches, exclusive of the proboscis. The head is brown, the occiput with scattered golden scales; the proboscis, antennæ and palpi brown, the latter tipped with light colored hairs at the apex. The thorax is blackish-brown, with two naked, light brown stripes in the central portion, extending from near the anterior margin, posteriorly for two-thirds the length of the thorax, and with many golden scales so disposed as to form longitudinal streaks; a central narrow, broken one and two lateral ones which join anteriorly and become more or less diffuse. The pleura are brown with small, inconspicuous patches of soiled whitish scales. The abdomen is smoothly clothed with dark brown scales and has narrow yellowish bands at the base of the segments; at the sides these bands become slightly broader, and beneath the abdomen is yellowish, with scattered brown scales. The legs are very dark brown, the femora lighter beneath, and with a white dot at the apex, the tibiæ and first two tarsal joints narrowly white-banded at each end and the remaining tarsal joints banded narrowly only at the base, the apical bands on these joints being represented by a few light colored scales. The wings do not differ essentially from others of the *Culex* tribe.

EGGS ON THE MARSH.

Early in the summer it became desirable to know the approximate number of mosquito eggs in the mud on an undrained area of salt marsh as compared with the number on a drained area. With the decrease in the number of adult mosquitoes a corresponding decrease in the quantity of eggs laid must necessarily follow, and to ascertain the proportion of decrease that one, two or three years' drainage would produce, a series of examinations was made.

It may be well to state at the beginning that the physical features of the salt marsh are not at all uniform. A tidal marsh is

constantly increasing in heighth, principally by the root growth of the sedges and grasses it supports, and it is not until a height is reached above that covered by ordinary tides that mosquito breeding places are formed. Such a meadow constitutes what in Bulletin No. 207 of the New Jersey Agricultural Experiment Station is called a marsh of the third type; the first and second types representing types not capable of breeding mosquitoes. As a broad, level expanse without depressions a marsh of this type produces a brood of mosquitoes only at rare intervals. At a very high tide the water spreads evenly over the whole of such an area and in a few days thereafter disappears by evaporation and absorption though the turf may remain saturated sufficiently to sustain life in larvæ that have hatched previously, until a heavy rain or another high tide again covers the meadow with water. In water covered in this way for a period of two or three weeks a brood of mosquitoes may reach maturity; but usually the surface becomes so dry that few if any larvæ survive. Two broods may develop annually on such a marsh, one on the heavy spring tides and another on the fall tides and rains. Territory of this kind is not considered *bad* breeding ground, for aside from the broods being limited in number they are usually small.

A meadow of the above description is rather uncommon in large tracts, though sometimes we find areas one-fourth to one-half mile square. Usually a meadow has depressions of varying depths more or less numerous over its surface. Before these can dry out under natural conditions it means that the turf of the level meadow must be dry to a depth equal to the depth of the depression; thus deep holes contain water longer than shallower ones and are also the first to receive water by percolation after a rain.

Water in these depressions, as a general rule, contains a much greater proportion of mosquito larvæ to the square foot of surface, if they occur there at all, than the water over the surrounding level meadow, and for this reason it was supposed that muddy bottoms were favorite places for oviposition. Yet we noted that some pools had no larvæ at all or only a small percentage of what others had, and it became important to know which were preferred for oviposition, in order that sod examinations for eggs might be comparative.

Watching the marshes immediately after perigee tides developed the fact that it was in the older depressions that most larvæ were found, the newer ones or those in process of formation containing fewest. Samples cut from dry depressions showed that out of the old ones hundreds of eggs could be washed, while in

new ones only one or two from several square inches and mostly none at all could be found. Yet it was common to find a few dozen or even more larvæ in nearly all these new depressions when filled; why not eggs? Still later, investigations showed that while the large majority of eggs are laid in old depressions, a scattering of eggs is deposited over certain parts of the level meadow, and later the resulting larvæ are concentrated in the forming pools as the meadow begins to dry; hence the presence of larvæ in pools where no eggs are found.

The formation of marsh holes often starts with the long grass falling over into some slight depression, broad and imperceptible to the eye. Then, becoming water covered, decomposition begins promptly and sometimes this is hastened by a deposition of iron which forms over the submerged grass. New grass does not start in such a spot and ere long a shallow hole is eaten out of the soft turf. The grass at the edges of such a hole, part of whose root system has been loosened, falls over into the depression and as it decomposes adds soil to the bottom. As the water collects and remains some time after the recedence of a high tide, it eats further and further at the edges into the living sod. Eventually the center gets out of range of the falling grass and assumes a smooth aspect, sometimes clayey, if the meadow has a deposit of clay over the turf, and sometimes rusty if an iron rust is formed over the decomposing grass. In pools formed in such a depression mosquito larvæ occur rarely, never in any numbers, and eggs are never found in the mud. But eggs may be found on the sod around the edge of the hole and in fact sparingly over all the level meadow; so as above stated the larvæ in such pools come from the eggs around it.

As the smooth center of the depression becomes larger it gets darker because of the rotting of the turf, larvæ become more numerous and eggs are then found in small numbers. Very often pools of this character continue to increase in size without any vegetation taking root in it; but because of the standing water sedges and joint grass frequently get in; and thus we have a tendency toward a reversion to the original type of marsh. But these plants do not thrive under such conditions and finally die, leaving a decayed stubble at the bottom. The decaying, furthermore, has resulted in spreading a black vegetable mould over the bottom, and when this condition is reached the ideal for mosquito oviposition is accomplished. Tens of thousands of larvæ are found in a pool of this character and as many as fifty eggs and egg shells have been found in a square inch of sod.

Besides rusty or smooth clayey bottoms there are depressions

with other conditions under which larvæ do not breed abundantly. Nearly all of these occur in depressions in patches of three-square rushes among salt grass, though it is not uncommon to find them directly in the latter. The most numerous are those over the bottom of which a uniform, smooth, mossy growth develops. No eggs have ever been found upon this, and when such growth completely covers the bottom only such larvæ are found in it as have been washed in from other places. There are usually fewer larvæ in these pools than in even clayey ones, and this is explained by the fact that they are usually in sedge areas where, as far as investigations go, no eggs are deposited.

After such pools have been dry for any length of time the growth becomes dark in color, leathery in texture, cracks and finally breaks up into small pieces, the edges of which curl up and expose the soil or sod beneath. It now may become a breeder again, for upon this exposed soil mosquitoes sometimes oviposit. In time these cracks are again covered with new growth and again it ceases to be a breeder of any extent.

Of more rare occurrence are pools coated at the sides and bottom with a white spongy growth, apparently due to extreme stagnation of the water and those in which the water is pale green in color from an algal growth. Larvæ have never been found in the former in any great numbers and when present are attacked by a disease which kills them before they reach the pupal stage. The water in the latter is of a pale green color, perfectly clear and with numerous bubbles in masses over the surface. In half a dozen pools of this kind none contained a single larva though other pools close by were crowded with them.

There are still other pools which have over the surface a thick frothy brown coat and in these larvæ are rarely or never found.

In examining sods for eggs it was at first the practice to break up a square inch in water, and rinsing thoroughly until only the loosened shreds of turf remained. Then a portion of this sediment was removed to a shallow white bottomed dish and carefully examined until all the sediment was used up, when another inch of sod was broken up. Not only eggs but every shell from which larvæ had hatched could be detected in this way. Later it was found that all eggs as well as shells were either directly upon or only very slightly beneath the mud surface and the method was modified to forcing water directly from a faucet upon the sod, and this in two or three washings took practically everything from the surface. Practice made it possible to detect the eggs among the mud loosened by such a washing without removing it to another dish.

The Shrewsbury River marsh was drained early in 1903, and is the oldest drained marsh in New Jersey. It is at the present time so compact and evenly grown over with grass that it is difficult to find depressions upon it at all. Such as still exist are more or less thickly overgrown and with a top soil so hardened as to be scarcely inviting for oviposition even if mosquitoes were present for the purpose. Samples of sod were taken on June 25th from three depressions of this kind, and one from the top of the meadow; but in only one of the former were eggs found; a single whole one and a shell from six square inches of sod. And this marsh in its time equalled in mosquito output anything in New Jersey!

The Newark meadow was drained in the summer of 1904. Mr. Brehme who was well acquainted with it before drainage was requested to cut pieces of sod from what had been the worst breeding places, some from the depressions and some from the level meadow and on June 27th four samples were sent in. The first was taken from the surface close to the upland. It was composed of turf with a thin layer of black mud over the top and was found to contain eleven shells to the square inch and no entire eggs. The second was also taken from the surface; in composition like the first, but from the center of the marsh and this contained two whole eggs and twenty shells to the square inch. A third was cut from a shallow depression about six inches in depth, well grown over with salt grass since drainage. It was very compact black soil mixed with turf and difficult to disintegrate and in this four whole eggs and six shells were found to the square inch. The fourth sample was collected from the bottom of the deepest depression that could be found (twenty inches); like the third it was compact from continued drying and contained neither eggs nor shells.

The Jersey City meadow was drained in the early summer of 1907 and a small brood of mosquitoes issued in the spring of 1908. Samples of sod were taken from it just as the second brood of larvæ had hatched and were either already dead on the mud or floundering in an extremely small quantity of water. A sample cut from a large, shallow depression covered with a scant growth of short salt grass produced six eggs and three shells to the square inch. A second sample taken from a deeper depression, the mud of which was still wet, though no larvæ or their remains could be seen, produced ten whole eggs and twelve shells to the square inch. A third sample of pure mud scraped from a still deeper depression in which there was a little water and a concentrated mass of larvæ yielded four eggs and two

shells to the square inch. The fourth sample from the bottom of a depression fifteen inches in depth containing neither larvæ nor water, though the soil was moist, produced six eggs and eight shells. All these samples were practically the same in composition; black mud mixed with more or less root fibers.

Examination of samples collected on the Elizabeth and Linden meadows by Mr. Brehme resulted in finding of neither eggs nor shells. The reason was that in both cases the samples were largely composed of loamy soil not attractive as places for oviposition.

The drainage of the Woodbridge Creek meadow was not completed until late in the fall of 1907, so from the standpoint of the number of eggs present was regarded as an undrained meadow. A collection of sods was made on June 16th and again on August 6th, three samples being taken the first time and four the second. The first sods were taken just after the second brood of larvæ had hatched and were dying in immense numbers in the bottoms of the depressions, though a few pools were yet present. The first sample composed of mud mixed with a little grass contained no eggs at all. The second taken from a depression which still held a little water in which larvæ were concentrated, contained two eggs and one shell to the square inch. The third was cut from a deep depression with no larvæ nor water, but was still very moist and was found to contain nineteen whole eggs and thirty-one shells to the square inch.

The second lot was collected with the idea of getting samples supposed to contain few or no eggs as well as those thought to contain many. A sod cut from a hole heavily coated with iron was, as expected, barren of eggs. Another taken from the center of a depression over the bottom of which was a layer of smooth yellow clay contained two shells and no eggs in the three square inches examined. A sod cut from the top of the meadow covered with a thin layer of clay contained one whole egg and four shells. The fourth taken from a slight depression covered at the bottom with reed stubble and rotted sod, produced eight whole eggs and forty-six shells in the nine square inches examined.

The upper portion of the Raritan Meadow furthest from the mouth of the River, presents a condition different from the ordinary run of salt marsh. It has over its surface a rather heavy deposit of yellow clayey soil, and even the depressions eaten out of the turf have a thin layer washed from the surrounding meadow. It is not therefore an ideal mosquito breeding place and larvæ have never been found in any great abundance. But

in the aggregate the scattered larvæ make up a brood worthy of consideration and for this reason the place was ditched in 1908. Sod and mud collections were made on June 22nd and again on August 3rd. Ten samples were taken in all. They came from shallow depressions and from the top of the meadow; from some with thickly sodded bottoms and from those with smooth mud bottoms; but in no case were more than two eggs taken to the square inch and in six there was absolutely nothing though nine square inches were in a few instances examined.

The Cheesequake Creek meadow was drained during the summer of 1908 and from it samples of mud and sod were gathered on three occasions. The first collection was made by Mr. Brehme in late June and three samples were collected from a section of the meadow covered with a layer of clay. In these absolutely nothing was found in the way of eggs or shells.

The second collection was made on August 4th with the idea of discovering in which particular portion of a depression eggs were laid by preference. Accordingly from the first depression, which had drained off a few hours before, leaving a squirming mass of larvæ at the bottom, three samples were taken, one from the center directly beneath the mass of dying larvæ, the second from the edge, where pupæ skins carpeted the drying soil, and the third from a section of red stubble also in the center of the depression. In the first was found two whole eggs in the one square inch examined; in the second nothing was found in two square inches; but in the third fourteen eggs and seventy-seven shells were washed from six square inches. Thus it was evident that stubble was greatly preferred to the smooth mud upon which nothing grew. From another depression, coated at the bottom with a leathery vegetable growth, two samples were taken, one with a large piece of the growth and another from between the cracks brought about by drying, leaving the mud exposed beneath. From the first nothing at all was taken, but in the second one whole egg was found in four square inches.

A third collection was made August 31st, on the upper Cheesequake and four samples were taken. Number one was from the level meadow directly at the edge of a pool containing many larvæ. The bottom of the pool itself was of a clayey character where experience has shown very few or no eggs are found. In this sample fifteen eggs and fifty-three shells were found in four square inches and if this condition existed around the whole of the pool, it fully accounted for the number of larvæ present. Number two was also taken from the level meadow at the edge of a small pool containing some larvæ. The bottom of this pool

was thickly covered with fallen grass and again, in such situations eggs are not found. From a sample two inches square one egg and twenty-six shells were washed.

Two other samples were taken on this occasion both from the top of the meadow and away from all depressions. Both had a top layer of clayey soil and as expected, nothing at all was found.

On the Matawan meadow three shallow pools which then contained an abundance of larvæ were staked out August 10th. On the 21st the depressions, then dry, were examined and a number of sods cut from the center, sides and from the top of the edges. No eggs were taken from within the depressions themselves, and only seven were taken from two square inches from around the edges. A faint coating of iron was over the depressions which was not noticeable when water filled, and this undoubtedly accounts for the absence of eggs within them.

Though insufficient knowledge of the egg-laying habits in the early part of our investigations rendered collection somewhat incomparative, yet certain conclusions can be drawn as to the relative abundance of eggs on an undrained meadow and on one which was drained some years ago.

In each case the samples were taken from such a variety of situations that on nearly every meadow certain sods might very fairly be compared. These sods composed of rotted turf taken from a number of places always showed a large number of eggs. On the Cheesequake and Woodbridge areas, for instance, both practically undrained, a maximum number of about two whole eggs and sixteen shells and nineteen eggs and thirty-one shells, respectively, were found on a square inch.

Likewise the Jersey City meadow drained in the same year as the Woodbridge, but earlier in the season showed a maximum of ten whole eggs and twelve shells to the square inch of similar sod. But on the Newark meadow drained several years before, nearly everything found was shells, eleven in one square inch as against no whole eggs and, in another instance, twenty shells as against two whole eggs. Thus it seems very evident that the eggs are disappearing from this meadow. Again, the Shrewsbury meadow drained earliest of all shows scarcely any signs of eggs whatever, though the sod examined was of the same kind as the others, only more compact from the longer absence of moisture.

It seems probable that these eggs are capable of retaining their vitality on the meadow for several years, because some eggs were taken from depressions in which no larvæ came to maturity last year and in which there could not have been any oviposition this year, although two previous lots partly developed in them.

REPORT

OF THE

ENTOMOLOGICAL DEPARTMENT

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

JOHN B. SMITH, Sc.D.

For the Year 1909

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REPORT OF THE ENTOMOLOGIST.

REPORT OF THE ENTOMOLOGIST.

By John B. Smith, Sc.D.

GENERAL REVIEW.

The growing season of 1909 began with cool, wet weather, but without the unusually heavy rains of 1908. This was followed by droughty conditions, which continued during most of the summer and fall, favoring insect development in a general way.

In the orchard the usual pests were present in full force, beginning with plant lice and ending with heavy crops of scale in late fall. Plum curculio and codling moths exacted a heavy toll, and a variety of minor pests attracted local and unusual attention. The more prominent of these pests are specifically referred to on a later page.

Field crops were no less troubled. Plant lice on peas came early, those on cantaloupes and pickles later, cabbages suffered until late fall, while there was scarcely one crop that escaped injury altogether from pests of this sort. Sweet potato growers in general profited by the results of the Station's work and suffered less from insect pests than usual, where ordinary precautions were taken; while growers of white potatoes suffered at least as much from dry weather as from white grubs and the common beetles. Angoumois grain moths took their share of the wheat crop, although this share was pretty generally kept down to a minimum by early threshing. Army worms appeared in several counties and sometimes over considerable areas. Cabbage maggots were further studied and some interesting notes were made.

Small fruits were heavily taxed and strawberries in particular were cut by leaf roller and weevil. There are many hundreds of acres in strawberries at this time, and in Cumberland and Burlington counties the area is increasing. The subject has been considered of sufficient importance to warrant the preparation of a bulletin, all the material for which is in hand.

The shade tree insects were more attended to than ever befor and the extraordinary abundance of elm leaf beetles attracted a tention throughout the State and exhausted our stock of bulleti dealing with the subject. A very concise essay on the princip injurious species, illustrated by two colored plates, was prepar for the State forestry commission, and is published in their r port for 1908.

The threatened introduction of the brown-tail moth demand all the efforts of the entire entomological force, and it is believ that the efforts were effective. No trace of the species was r ported anywhere in the State during the summer. This matter taken up in detail later on, and is of prime importance, not to t farmer alone, but to all citizens of the State.

The close relations with shade tree commissions throughout t State have been continued, and the aid of the department has bee given in many cases to communities carrying on their first cam paign against insect pests.

Commercial insecticides continue to increase in number an variety and some of them promise well. They are getting alt gether too numerous, however, to make it possible to carry on sy tematic tests with the present organization. This kind of wo requires orchards and field plots of considerable extent, over whi the entomologist has full control and for which he needs the sistance of trained men, as well as temporary field hands. O farmers and fruit growers are usually very ready to co-opera but there are practical considerations which make risky appli tions inadvisable, while spray control is difficult. Neverthele some definite results were obtained.

The attendance at meetings of agricultural and horticultu bodies throughout the State has been continued and so has the tendance at the entomological societies in Newark, New Yo Brooklyn and Philadelphia.

The meetings of the Entomological Society of America, of t Association of Economic Entomologists and of the nursery spectors were held during the winter of 1908–1909 at Baltimo Maryland, and were attended by the entomologist. The work the inspectors is becoming ever more systematized and irregul ties in shipments are promptly brought to the attention of the ficial concerned.

At the request of Mr. Silas R. Morse, Curator of the State Museum, a new edition of the list of insects to be found in New Jersey was prepared for publication as a portion of his report, and to this all spare time of the entomologist was devoted. The last previous edition was published as a special report of the State Board of Agriculture in 1900, and made a book of 755 pages with 328 figures in illustration. The new list omits some of the economic features of the earlier one but adds a large number of species, much additional information and some additional figures, making, it is hoped, a much more valuable book. The 1900 edition has been long exhausted, and there is constant demand for a similar work from educational institutions throughout the State.

There has been no change in the staff, and Messrs. Dickerson, Grossbeck and Brehme have, as usual, co-operated with the entomologist in the general work of the department when not fully engaged in their special work. Miss A. E. Meske has been continued as clerk and stenographer, and the correspondence for the fiscal year closing October 31st, amounts to 3,000 pages of letter book or about 4,100 individual communications. Circular letters are not included in this enumeration.

Bulletin No. 216, dealing with the house mosquito as a city, town and village problem, was published in late fall of 1908, and bulletins on strawberry and sweet potato insects are in hand for early publication.

ENTOMOLOGY IN THE CROP BULLETIN.

During the month of May insects were little mentioned by the recorders. At North Arlington, in Bergen county, the small number of asparagus beetles was noted, and in Egg Harbor City, the slight injury to the strawberries by the weevil was commented on. This was in striking contrast to last year, when injury was heavy at the corresponding season. At Merchantville, injury by the cabbage maggot was noted.

In the June number, Secretary Dye makes the pessimistic statement that "apple trees are generally injured or entirely destroyed by the scale," which statement, fortunately, has no basis of fact. At Dover, Morris county, potato beetles were reported in

force, but owing to cool, cloudy weather were slow in reproducing their kind. Insects in general were so scarce that the crows became unusually troublesome to farmers and other birds whose nests they plundered. At Livingston, in Essex county, potato beetles were also reported as plentiful; but at Green Creek, Cape May county, their scarcity attracted attention.

At North Arlington, Bergen county, the cabbage maggot destroyed some plants; at Rahway, Union county, "bugs and insects have caused no small amount of injury," and at Hopewell, Mercer county, the dropping of maple foliage, due to plant louse attack, was noted.

As to the San José scale, New Market, Middlesex county, reports it as "not as bad as last year;" but at Jacobstown, Burlington county, it is reported as "gradually working in on our fruit trees."

The abundance of "rose bugs" was commented on from Jacobstown, where they attacked fruit and fruit trees, and from Blue Anchor, Camden county, where they threatened the blackberry crop.

Curiously enough, not a word appears concerning the army worm, which appeared so abundantly in several sections of the State over considerable areas, during this month of June.

During July, "worms in apples" attracted the attention of the North Arlington recorder, while at Jacobstown, flies were so abundant and annoying to cattle as to materially reduce the flow of milk in conjunction with heat and shortness of pasture.

From Riverton, Burlington county, comes the record that "lice are injuring cantaloupes and cucumbers," and that statement applied pretty generally in the Delaware valley region at that time.

During August, scale conditions became worse at Frenchtown, Hunterdon county, apples and peaches being "damaged by scale, which seems worse than ever." At Glassboro, Gloucester county, "the melon louse almost destroyed the cantaloupe crop in some places," and at Cedarville, Cumberland county, potato bugs were very thick, "an average of twelve and three-quarters bugs waiting at each sprout as it came through the ground."

During September, the San José scale, as is its wont, became more conspicuous and its effects more noticeable. At Baptistown, Hunterdon county, many large apple orchards are reported dead from scale. At Robbinsville, Mercer county, there was a

good crop of apples where the trees were not destroyed by scale, while at Jacobstown the scale was hard at work on the trees.

At Dover, Morris county, it was white grub year, "and nearly all crops have suffered from their attacks." Specifically, potatoes, cabbages and root crops were mentioned, and, incidentally, plant lice on cabbage were noted.

RECORDS OF THE EXPERIMENT ORCHARD.

During the season of 1908 the San José scale became distinctly prominent on some of the trees and decidedly noticeable on all. It was determined to make a fall treatment, such as I was recommending to the office correspondents, using a miscible oil for the apples and pears, and a lime and sulphur mixture for the peaches and plums.

A lot of San-U-Zay oil had been recently received for trial and there was a sample of commercial lime and sulphur from the Grasselli Company. Mr. Dickerson made the application on the afternoon of November 9th. The weather was warm and sunny, there was almost no wind, and, in every way, the day was ideal for spraying.

The oil was used at the rate of two gallons in twenty-four gallons of water, one and one-half pounds of sal-soda having been dissolved in the water before adding the oil. The oil mixed only fairly well, free oil remaining on the surface, and the milky mixture was not even. Nevertheless, it sprayed perfectly and was thoroughly put on, a step ladder being used to get to the tips of the larger trees. After the work was done the trees had a decidedly oily appearance, which persisted for some days.

The lime and sulphur was applied at the rate of two and one-half gallons to twenty-two gallons of water or about one two nine, and the material mixed and sprayed well. It was applied as thoroughly as the oil and in the same way, leaving the trees a bluish gray when dry.

Both materials proved equally effective. It would probably be too much to say that every scale was killed off, even where the material hit, but it is certain that it was almost impossible to find a live scale in late September, 1909, and on a full crop of Baldwin apples not a scale was seen. The Gravensteins were equally clean

and there was no crop on the Grimes Golden. There were no Ve mont Beauty pears, but the trees seemed almost free from scale At all events, from the practical standpoint, the trees are clea and of no use for experimental purposes with scale killers.

But successful as the applications were as against the scal they were unavailing in preventing the development of plant li which made their appearance in great numbers, and gave oppo tunity for testing some preparations then in hand.

May 18th, sprayed the Baldwin and Gravenstein apples wi arsenate of lead, one pound in fifteen gallons of water, for co ling moth. May 29th the application was repeated by Mr. Dic erson, with a slightly stronger mixture. The application w not as well made as it might have been, especially in the upp part of the trees, but there were few wormy apples on the Grave stein and not many more on the Baldwin. But the season w peculiar, and there was a well-marked tendency to a second broo which got into the thickly-clustered Baldwins and spoiled qui a few. No spraying was made for this, and no application w made of any fungicide. The apples, therefore, were not so cle as they should have been, scab and rots showing on a goodly pe centage. There were, perhaps, two barrels in all, and not ov half were sound and clean, though less than five per cent. we wormy; most of these second-brood attack.

Tree 31 is a German Prune, and that has always set heavi and yielded practically nothing. Plum curculios have had t bulk of the crop, and rot has claimed the rest, finding entrance punctures made by the beetles even where no larvæ developed.

I determined to try to change this record, and, on May 18t sprayed thoroughly with arsenate of lead, one pound in fifte gallons of water. May 29th Mr. Dickerson sprayed with slightly stronger mixture, and on May 30th I sprayed yet a thi time, using up some material that had been left from the previo day. The tree was certainly well covered when these applicatio were completed.

The result was quite obvious, the great majority of the fru remaining clean and free from punctures. But soon after t beginning of June, plant lice became very plentiful, and especial they began to group and cluster on the fruit stems. This check development and the prunes began to yellow, making treatme imperative.

June 16th, sprayed thoroughly with sulphate of nicotine, one-fourth ounce in two gallons of water, the mixture being forced into the foliage from the underside as far as possible. The effect was excellent. June 18th the lice were practically cleaned out, but the effects of their feeding remained. Many of the fruits were shriveled, stunted, light-colored, and dropped soon afterward. For a time all went well, but late in July the drought began to show its effects, and again fruits were dropping. To determine whether the curculio was responsible in any way, Mr. Grossbeck gathered sixty-one dropped fruits on August 5th. Of these seventeen were entirely sound, and dropped simply because the tree could not hold them. Forty-four showed curculio marks, but thirty-three of these were surface marks only, from which no larval feeding had ever started. Five fruits only showed curculio larvæ at work, and on six rot had started from the egg punctures.

August 12th Mr. Grossbeck gathered another lot of thirty-one drops, of which eleven were perfect. On fourteen there were curculio crescents, but the fruits were otherwise sound. On six there was rot starting from curculio punctures. In not one case was there any indication of larval feeding. In other words, out of ninety-two fruits that dropped in early August, only five had fallen because of direct curculio injury.

After the drought broke, the remaining fruit matured and was excellent.

Tree 3, a black Tartarian Cherry, became very lousy late in May, and on June 1st Mr. Dickerson sprayed the lower branches with sulphate of nicotine, one-fourth ounce in one gallon of water. The species was the black cherry louse, which had already curled some of the leaves and tips so closely that the application was, of necessity, more or less imperfect. June 2d, 3d and 5th, the results were noted and were quite satisfactory. Wherever the spray had actually reached the insects, it had killed them. But in many of the curled leaves there were plenty of living examples to provide for prompt reinfestation.

June 16th Mr. Dickerson treated the tree as before, but with Nico-fume at the rate of one ounce in two and one-half gallons of water. June 18th the results were excellent. Wherever the spray had reached them the lice had been killed, and even in the curled leaves the spray seemed to have reached pretty effectually.

There was no further increase after this period, and no other applications were made.

Tree 48 is also a black Tartarian Cherry, which likewise became lousy late in May. June 1st, Mr. Dickerson sprayed this with "Nico-fume" at the rate of one-quarter ounce to one gallon of water, applying as thoroughly as conditions permitted. The application was a duplicate of that on tree 3, save that "Nico-fume," instead of sulphate of nicotine, was used. June 2d, 3d and 5th, examinations were made and not 50 per cent. of the insects were killed even where directly hit—in fact, only the youngest forms were affected and the tree was getting rapidly worse. June 16th, the tree was again sprayed as before, but with sulphate of nicotine at one-quarter ounce to one gallon of water. This proved satisfactory, and on the 18th, the lice were so far diminished that no further treatment was made.

Tree 43 is a Richmond Early Cherry, and, like the others, became covered with lice in May. June 1st, Mr. Dickerson covered it thoroughly with Cooper's V_2 fluid at the rate of one part in fifty parts of water, or double the strength advised in the labels. The entire tree was sprayed and especial effort was made to get into the curled leaves. June 2d, 3d and 5th, found that the results were even worse than those on tree 48, only a small percentage of even the youngest forms being killed. June 16th, another application was made, this time sulphate of nicotine, one-quarter ounce to one gallon of water. This was effective, although on the 18th living lice could yet be found in the curled leaves at the tips.

The peach trees nearly all did remarkably well during the season. They matured good crops and were not bothered by insects of any kind. There was little rot and for two months there was a continuous supply for the family and some of the neighbors.

INSECTICIDE RECORDS.

ARSENATE OF LEAD.

The analyses made by the Chemical Department show continued improvement in the products on the market in the direction of uniformity, and all the well-known brands may now be relied upon. An excellent tendency on the part of manufacturers is to state the

actual percentage of arsenic contained in their material, and this gives an excellent basis for the farmer to measure the strength of his applications.

In the State of New Jersey, Paris green containing 50 per cent. arsenic is standard according to law, and when Paris green is used at the rate of one pound to fifty gallons of water, the equivalent strength at which arsenate of lead is to be used is as many gallons of water as it contains percentage of arsenic. In another shape:

Paris green, one pound in fifty gallons of water, as for potatoes—

Arsenate of lead,	10 %	1	lb. in	10	gallons.
" " "	12½ %	1	"	12½	"
" " "	15 %	1	"	15	"
" " "	18 %	1	"	18	"
" " "	20 %	1	"	20	"

Paris green, one pound in 100 gallons, would of course require twice as much water in gallons as the arsenate of lead contains per cent. of arsenic, *i. e.*,

Arsenate of lead,	10 %	1	lb. in	20	gallons.
" " "	15 %	1	"	30	"
" " "	20 %	1	"	40	"

and so on at the same rate.

Paris green, one pound in 125 gallons, should have the percentage in arsenate of lead multiplied by 2¼ to obtain the number of gallons, and for one pound of Paris green in 150 gallons, the percentage in arsenate of lead must be multiplied by 2½.

Arsenate of lead is not quite so prompt in its effect as Paris green at the same relative strength, so it is quite usual to recommend a proportionately greater strength than is indicated by the actual percentage of arsenic. Just how much that increase should be depends upon circumstances, and no general rule can be formulated; but, in view of the fact that arsenate of lead is absolutely safe at all strengths and that it sticks so closely, an increase of one-half of the theoretical requirement would be about right in most cases. That is, where one pound is indicated, use one and one-half pounds to obtain quick action against hardy species like potato beetles. This, according to our table, would make one and one-

half pounds of 20 per cent. arsenate of lead in twenty gallons of water, which has been actually successful in the cases observed by me.

Some persons have used Paris green much stronger than one pound to fifty gallons of water, and in that case the percentage of arsenic in arsenate of lead must be divided, *e. g.*, where one pound of Paris green in twenty-five gallons of water is indicated, divide by two and use ten gallons of water to one pound of 20 per cent. arsenate of lead, which is about as strong as it need ever be used for any purpose. In many cases a very thorough application of a moderate strength mixture is better than a scanty application of a very strong one.

During the two or three years last past some of the manufacturers have attempted to produce a dry arsenate of lead and have secured a very fine flour-like material containing about 26 per cent. of arsenic. This is primarily intended for applications with a powder gun or bellows, and none of it has been tested in New Jersey so far as I am aware. Whether it will be found to have advantages over the paste form now in use remains to be worked out.

OTHER ARSENATES.

Among other materials sent in for trial during the season were sample lots of arsenates of iron, zinc and barium, carefully prepared with definite information as to the percentage of arsenic contained. It was intended to test these comparatively, and tests on foliage were actually begun. But the demands of the season in other directions were so urgent that the experiments were not carried to an end, and no useful results were obtained.

Theoretically, arsenate of barium should prove a valuable insecticide, costing less than either the Paris green or arsenate of lead; but it will require careful tests to fix their relative value and the margin of safety for foliage in the new material.

Arsenate of iron is being developed in France and is said to promise well, comparing in effectiveness with arsenate of lead and withal much less expensive.

LIME AND SULPHUR.

The lime and sulphur combinations as against San José scale on peach and plum seem to have demonstrated their superiority over all other materials, whether the home-made or the commercial preparations are used. Indeed, as a matter of fact, more uniform results are obtained with the commercial preparations, and that is not surprising when we consider their greater uniformity in strength and combination. It is not that they are better scale killers than the miscible oils, but that, on peach trees especially, the incidental effect on certain diseases is so greatly marked that their use is indicated in any event, even if not as a scale killer chiefly. It has also been demonstrated that, as a fungicide, this material has advantages over copper, and that its effectiveness and range of usefulness is much greater than heretofore suspected.

The material result of this has been that the number and variety of preparations containing sulphur has greatly increased, and that efforts have been made to simplify the manufacture for the farmer.

HOME-MADE CONCENTRATE.

One of the questions frequently asked by fruit growers is, why cannot we make a concentrated mixture that keeps indefinitely, just as well as the manufacturers can? The answer to this is given by Professor John P. Stewart, in Bulletin 92 of the Pennsylvania State College Experiment Station. He points out the difficulties in the way of a chemical combination, and shows the effect of the air on the mixture where an excess of lime is used. He finds that a satisfactory concentrate can be made according to the following formula:

50 pounds best stone lime (not over 5 % impurities).
100 pounds flowers of sulphur.
50-55 gallons of water at finish.

Put ten gallons of water in kettle and start fire. Place lime in kettle. After slaking is well started add the dry sulphur and mix thoroughly, adding enough water to maintain a thin paste. After

the slaking and mixing is completed, add water to make sixty-five gallons, and boil down to fifty to fifty-five gallons, stirring until all signs of sulphury scum disappears. It requires about one hour's vigorous boiling to complete the combination, and boiling may be stopped as soon thereafter as the liquid, when dipped and poured, runs clear and free from all signs of undissolved sulphur.

This material may be used at once, diluted with from nine to ten parts of water, or may be run into barrels for storage. It should be strained to get rid of undissolved materials or impurities, and the vessels should be completely filled and tightly closed to exclude air. If open barrels are used, cover the material with about one-eighth inch of ordinary paraffin oil, and this will prevent the formation of any crust and will preserve the material. If the combination is left uncovered a crust will form, and there will be some crystallization.

The exact amount of dilution will vary a little with the density of the concentrate, and it is best to use a hydrometer to test each lot. The spraying mixture should have a density of 1.03 and approximately nine or ten dilutions will be required to obtain this. If no hydrometer is used, dilute with nine parts of water.

This home-made concentrate will be a little cheaper than the commercial preparations, but where the latter can be obtained near by, so that freight charges are not too great, the gain will be so little that it scarce repays the installation cost and the labor expended in the making.

In the commercial preparations there have been two tendencies, aside from the preparation of the normal combination of lime and sulphur. One has led to the preparation of dry combinations, and the other to a solution of the sulphur itself by some chemical, *e. g.*, potash without combining with lime.

DRY SULPHUR COMPOUNDS.

Three compounds of this character were received. One of these was apparently a sulphite of soda, intended for summer use, but its action was so violent on foliage that very little was used. Exposed to the air it solidified, and no further experiments were made.

In the report for 1908, some reference was made to a combination in granular form received from Mr. B. F. Hires of Bridgeton, N. J. This material is now commercially manufactured by the Sulfo-Chemical Company of Philadelphia, under the title "Never-Scale." The applications made in 1908 were inconclusive, and by an accident those made in 1909 were rendered void by a second spraying with a different material.

In early October, however, I spent a day with Mr. Hires examining a number of orchards—peach, apple and pear—in which the "Never-scale" had been used under normal field conditions, and the results were undoubtedly good. Some badly infested apple trees were almost entirely free from live scale, although the trunks and branches were yet plastered with dry scurf, and a number of almost equally infested peach trees were even better. On some old Baldwin apple trees said to have been badly infested, which were sprayed in the fall of 1908, and again in the spring of 1909, there was a mere trace on the fruits, and on a peach orchard of considerable size the trees were practically clean.

In each case the application had been very thorough and much whitish powdery material was yet adherent to the surface of the bark where it was somewhat sheltered.

The material is prepared by pouring one and one-third gallons of boiling water over each pound of powder, stirring thoroughly and then applying at once. Mr. Carnell, the originator of the mixture, suggests a few minutes' actual boiling to get out all the soluble sulphides; but this had not been done by either of the parties with whom I spoke. I am informed that some of the material was stirred in cold water and used with good results, but I saw no trees treated in this way.

That the material is effective when properly made and applied seems certain. Whether it has any advantages over the liquid concentrates in cost and convenience, remains to be demonstrated.

A concentrated dry lime and sulphur was received from the Merrimac Chemical Co., in the fall of 1908, and laboratory experiments made November 30th indicated that, when mixed at the rate of one ounce by weight, with eleven fluid ounces of water, a liquid similar to the normal lime and sulphur mixture was produced.

A three-pound can sent in for trial was dissolved in four gallons of water and applied with a compressed air sprayer to a row of

young apple trees on the College Farm, February 25th. The application was thoroughly made on the trees which were not badly infested except on the trunks. They were scaly when received from the nursery and were set out for experimental purposes only.

Late in June the trees were carefully examined by Mr. Dickerson and most of the scale was dead and dry. No crawling larvæ or recent sets were noted at that time, but later in the season a slight infestation was noted. The material had been fairly but not altogether successful.

SOLUBLE SULPHUR.

In the report for 1908, some experiments made with Bogart's Sulphur Compound were reported, and that material was used in a somewhat different line during the season of 1909. Its results on scale insects were not sufficiently good to induce further work in that direction; but in the greenhouse, against red spider, it was found extremely useful. Most of the work was done in the horticultural department, because it developed very early that as a fungicide the material would prove much more satisfactory than as an insecticide. Mildew on roses was perfectly controlled and other advantages resulted from its use, which were not noted by my department. On plant lice it was only partially effective, and on white fly not at all.

From the B. G. Pratt Company I received several gallons of a similar material termed "Sulfocide," said to contain a much greater percentage of actual sulphur than the Bogart compound, and recommended for use, diluted from seventy-five to 100 times with water.

Most of this material also was turned over to the Horticultural Department, and its range of usefulness there was similar to that of the Bogart compound at a greater dilution.

One gallon was sent to a florist near Trenton to be used against red spider, plant lice and white fly. Applied at the rate of one part in 100 parts of water it was quite effective against red spider and plant lice, but did not harm white fly. It spotted, or rather discolored, flowers at that strength.

At the rate of one part in seventy-five parts of water it was entirely effective against red spider and plant lice, but ineffective

against white fly. It caused very slight injury to the more tender foliage. The plants treated were *Argeratum, Heliotrope, Geranium, Carnation, Chrysanthemum* and *Verbena.*

Complaints of red spider on conifers in nurseries were rather common, and, on July 3d, Mr. Dickerson tested the Sulfocide, one to seventy-five, on a few infested spruce trees in an Arlington nursery. July 6th, no living spiders could be found, and a single badly infested *Arbor vitæ* was sprayed at the same strength in a Rutherford nursery. This plant was in bad shape at that time, and suffering seriously from the infestation. As a result of the application it recovered and was in fine condition in early September.

On this same nursery there are large blocks of evergreens, and the spraying machine is kept busy throughout the season with a combination of whale oil soap suds and tobacco, which is only fairly effective. I sent them two gallons of Sulfocide with instructions to use at the rate of one to seventy-five, and was advised in due time that the application had been made. September 29th Mr. Dickerson looked over the sprayed plants, found them clean and healthy, and entirely free from red spider. No injury had been caused on any plants except some Colorado blue spruce. These, as the result of the application, had lost their characteristic blue color and had changed to the normal green of the other varieties. Whether this discoloration is permanent has not yet been determined at this writing.

There is undoubtedly a future for these sulphur combinations; but it may be as a fungicide, rather than as an insecticide, that they will find their most important use. Against such pests as the red spider they are almost specific, and their simplicity, merely mixing with water, commends them. There will probably be some practical limitations, as where there is danger of spotting flowers, or where lead paint may be discolored, or where a coloration like that of the blue spruce is in question; but for the large range of plants attacked by red spider, these sulphur compounds will eventually come to be most useful.

VACUUM OIL.

Some records were given of the results of applications made in 1907–'08 in my report for 1908, and reasonably good results followed the 1-15 applications made with material supplied through me. Other applications, made at the rate of 1–20, in accordance with the recommendations of the makers, were less satisfactory, and I have advised the company, again and again, that at this rate success was possible only under extraordinary conditions. This conclusion was again fully borne out in 1909.

In Camden, Gloucester and Burlington counties much of the Vacuum Oil was sold and used, and during the summer and early fall Mr. Dickerson and myself had opportunity to see quite a number of the treated orchards. In every case where the material was used at the rate of 1 to 20, the conditions were worse than before the application was made, and in some cases the failure was already so conspicuous in March and April that a second treatment was advised at a strength sufficient to do satisfactory work.

Careful analysis shows nothing in the Vacuum Oil that should render it any more effective than any other of the miscible oils, and none of the brands now on the market is satisfactory at a dilution of 1 to 20, except under unusual conditions. I have had success with "Scalecide" at that strength, but would not dare to recommend even this, generally, in that proportion, after the results of other field work under different circumstances.

Vacuum Oil is a good scale killer at the rate of 1–12 and fairly effective at 1–15. It is absolutely unreliable at 1–20, and the orchardist who uses it at that strength stands a good chance of losing his time, labor, price paid for oil, and his orchard as well.

It might be added that the Vacuum Oil mixture leaves the trees with a more greasy appearance than the other miscible oils, and that the signs of application remain much longer than with any other similar material.

"SAN-U-ZAY" SCALE OIL.

This material was referred to in the report for 1908, but at that time no work had been done with it. It differs from the other oils on the market in requiring the addition of sal-soda to the water before a proper solution takes place.

The directions for use as given late in the season were as follows:

"First, for making one barrel or fifty gallons of solution, put into a barrel two pounds of sal-soda, pour over it three or four gallons of hot water, which will dissolve the sal-soda in two or three minutes. Fill the barrel nearly full with any kind of cold water, stir it a little, pour in three gallons of San-U-Zay Oil, stirring it well, and you have the solution."

"Kindly understand that the use of the hot water, as given above, has nothing to do with it other than that it immediately dissolves the sal-soda; cold water will dissolve it slowly."

Some laboratory experiments demonstrated that the mixture could be very readily made, and that it remained stable a long enough time to be reasonably used. On long standing, *i. e.*, two or three days, the material separated into distinct layers which did not readily recombine.

One application was made on the apple and pear trees in the experiment orchard, and details are given under that heading. It is enough to say here that three pounds of sal-soda were used for fifty gallons of water as per the first circular issued, and that four gallons of oil were used in fifty gallons of water. The application was very thorough and entirely successful. Practically no living scale remained, and the trees remained almost scale free throughout the season of 1909.

On the College Farm, four rows of dwarf apple trees were sprayed December 23d, 1908. The trees were not badly infested, but needed attention. The combination used here was San-U-Zay Oil, four gallons; sal-soda, three pounds; water, forty-eight gallons. The application was made by Mr. Dickerson, very thoroughly, with a Deming pump through a Friend nozzle. The results here were not as satisfactory as on the experiment orchard. When a careful examination was made in late June of 1909, a few larvæ were found, but later in the season conditions became rapidly

worse, and in early October the trees were worse than they were the winter before.

Five gallons of material were sent in early December to a Moorestown orchardist, who applied it in an apple orchard in which some trees were very badly infested. The bulk of the orchard was treated with Scalecide, 1 to 15, and both were applied carefully in December. Unfortunately in his anxiety to do a thorough piece of work, the owner sprayed again in spring just before the trees started, and covered all the trees with Scalecide at the second spraying. I saw the trees in early spring and the effect appeared good, but I sent Mr. Dickerson to look at them again, July 13th, to make certain. His report was that even the badly infested trees were then apparently clean and the scale scurf was dead and dry. Of course, this experiment is vitiated by the second spraying with Scalecide, but the record may stand as a successful result of conscientious effort to control the scale.

Sufficient appears from the work done to indicate that this material is fairly reliable and that it ranks with some other brands of miscible oil on the market in effectiveness. It is sold by F. G. Street & Company, of Rochester, New York. The differences between the effects in the experiment orchard and in the College Farm may be due to the date at which the applications were made. In mid-November, the scales were not yet fully dormant nor the coverings sealed fast to the surface. In late December the coverings were sealed fast, the insects were fully dormant and the oil failed to penetrate sufficiently to kill.

COOPER'S V_2 FLUID.

The records of trials made with the Cooper sprays in 1908 were unsatisfactory, as appears from the report for that year, and a few other applications were made during the season of 1909, which are not much more convincing. Chemical analysis shows that these fluids are mostly methyl alcohol and carbolic acid, both volatile and, in concentrated form, violent poisons. Theoretically, both of these substances are good contact insecticides, and the only objection is that they evaporate too rapidly for best results. The difference in results shown in 1908 between the scale-infested twigs that were dipped and those merely sprayed is explainable when the

composition of the material is known. Where I dipped the infested twigs so that the liquid actually surrounded and penetrated, the results were good. Where I sprayed, covering as would be ordinarily done in practice, the material evaporated from the surface before it had a chance to penetrate through the covering scale to the eggs or insects below.

In December some pansy plants in a Station greenhouse were found infested by plant lice, and some poppy plants were found infested by red spider. On the 19th, Mr. Dickerson sprayed these plants thoroughly with the V_2 fluid, diluted with seventy-five parts of water. A few plants were left as checks in each case.

Practically no benefit resulted from the application, and a few days thereafter there was no observable difference between the check and sprayed plants in either series.

April 14th, chrysanthemum plants in the farm greenhouses became infested with thrips, and I sent out some of this material, directing its application at the rate of one to 100 with all the force available. Check applications were made in the laboratory at double this strength and proved unsatisfactory.

April 17th Mr. D. M. Jobbins, assistant to the horticulturist, reported that with two applications at the rate of 1 to 100 the thrips had been killed off without injury to the plants, and that some red spider infestation on the same plants had been also cleaned out. Tomato plants accidentally sprayed showed some burning at the edges of the leaves. Whether the moist atmosphere of the greenhouse favored the effectiveness of the material as against the dry air of the laboratory, can only be surmised. At ny rate the results were contradictory, and both sides are given.

June 8th the false maple scale, *Pseudococcus aceris*, was beoming conspicuous in certain sections of New Brunswick, and sent Messrs. Dickerson and Grossbeck with instructions to select badly infested tree and spray the trunk with V_2 diluted with fty parts of water. They reported their selection of a tree, and iat they had soaked the trunk and lower branches with the maerial. June 16th no benefit was noted as compared with adjacent ees, and on climbing into the tree itself, the upper part of the unk and the branches not sprayed were no worse infested than iose that had been treated.

The results are not sufficiently satisfactory to warrant recommendation, although not so uniformly bad as to warrant unreserved condemnation.

It might be added that tests made with the V_1 and V_2 fluids in Michigan during the season of 1908, and recently published, gave similar, unsatisfactory results.

ASPINWALL'S INSECTICIDE.

A pint bottle of this material was sent in with an urgent request that it be given a trial, and especially as against the elm beetle. Judging from appearance and smell it was a gas tar or phenol preparation, and, on May 12th, sprayed a small tree at the suggested rate of three ounces in one gallon of water. The beetles were actively feeding at this time in considerable numbers, and the test was a good one. No apparent lessening of injury was noted May 13th, and a number of the beetles were taken into the laboratory and fed on the sprayed leaves. May 15th the beetles were yet feeding freely, and not for several days afterward, when the leaves had become dry and uneatable, did any die and not then until after they had laid eggs. The tree was sprayed with arsenate of lead on May 18th, and the injury checked at once.

June 8th tried the material on apple plant lice. A small tree set last season was badly infested, and this was sprayed with the material at the rate of one ounce in three pints of water. The application was thorough, although in the curled tips not all the specimens could be hit.

June 16th the tree was worse than before; the spray had not in any way checked the increase of the insects, and the curled tips either from the insect injury or from the mixture, or a combination of the two, were browning up. Neighboring unsprayed trees were not worse, and others sprayed with other materials were decidedly better.

The supply being practically used up, and the indications so unsatisfactory, no more material was sent for.

TOBACCO PREPARATIONS.

From the Kentucky Tobacco Products Company I received for trial early in the season a quantity of two mixtures—"Nico-fume" and "Sulphate of Nicotine." Both were tobacco products, claimed to be nothing else, and I was asked to test them comparatively. This I did, on plant lice chiefly, and most of the tests are referred to in the records of the Experiment Orchard.

Briefly stated, Sulphate of Nicotine proved satisfactorily effective on green plum lice at the rate of one ounce in eight gallons of water. On black cherry lice the material was effective at the rate of one ounce in four gallons of water, wherever it was possible to hit the insects at all.

"Nico-fume" was not used on the green lice, but on the black cherry lice it was not satisfactory at the rate of one ounce in four gallons of water, killing only the young forms; but at the rate of one ounce in two and one-half gallons of water it killed all that it reached.

Mr. Dickerson also used both "Nico-fume" and Sulphate of Nicotine on some maples on the college grounds, infested with the green maple louse, *Chaitophorus aceris*. At the rate of one ounce in eight gallons of water both materials were equally effective, killing everything hit. It had been intended to run down these proportions to the ineffective point for both, but unfortunately by the time these results were determined there began the change in weather, which in a few days deprived us of experimental material, and the matter was, perforce, dropped.

Late in June and early in July Mr. Dickerson found a lot of lousy nasturtiums, and sprayed one lot with Sulphate of Nicotine, the other with "Nico-fume," both at the rate of one ounce to six gallons of water. The Sulphate of Nicotine killed all the plant lice hit, but the "Nico-fume" killed only a large percentage of them. The lice here were black.

"Nico-fume" was also used on green lice on sweet peas at the rate of one ounce in six gallons of water, with unsatisfactory results, a large percentage of the insects remaining unaffected.

Both these materials are undoubtedly powerful insecticides, but the Sulphate of Nicotine is much the more effective. Lack of time and material prevented more extensive tests and the scanty records here given are mere indications.

BENEFICIAL INSECTS.

CHINESE MANTID.

This insect seems now to have definitely established itself in the State, although nowhere in very large numbers. In none of the larger colonies has it died out entirely, and, at two points at least, it is present in some numbers. One of these is in the scrub land near Anglesea, where it was established by Mr. Laurent; the other is on the Bobbink and Atkins Nurseries, where it seems to have been introduced on imported nursery stock exactly as it first came to the Meehan nursery. The surroundings that it finds there are identical with those that favored its multiplication near Philadelphia, and the insect is frequently seen and recognized by the workmen in the nursery. Mr. Dickerson found several examples in late September while making inspections.

Only one new colony was put out this year, and that was on April 10th, in Dover township, Ocean county, a few miles north of Toms River. At this point, in an oak scrub just west of the salt marsh, Mr. H. H. Brehme tied out rather more than one hundred egg-masses, received from Mr. Laurent. It is, of course, too early to determine whether any of the specimens survived and matured to propagate their kind, but they are certainly in an ideal location to secure prey.

GENERAL CROP PESTS.

PLANT LICE.

As already stated, this was a plant louse year and many of the well-known pests appeared in great numbers throughout the season.

Among the first to attract attention throughout the State was the maple louse, *Chaitophorus aceris* Linn., on the Norway maples.

The season started in favorably for the development of the trees, and they became clothed with a very heavy and very soft succulent foliage in early May. Then came cool, moist weather, excellent for the trees and also for the plant lice, which appeared in colonies on the undersides of the largest and finest leaves. These colonies increased in size and number as favorable weather continued, and soon the honey dew became evident. This maple louse is a large species as plant lice go, and its feeding is gross. The demands made by the unusually dense foliage and the plant lice as well, became more than the trees could bear, and in late May and early June, foliage began to drop to such an extent that demands for methods of treatment came in with every mail. Keeping in mind the experience of other seasons, no insecticide applications were advised, and the increase in lady-bird beetles and parasites in June, justified the belief that the infestation would be brought to an end as soon as weather conditions changed. This happened well along in June, when droughty and warmer weather was established. For a time the dropping of foliage seemed intensified, but this was an advantage rather than otherwise, for the trees thus got rid of the excessive foliage and went through the rest of the season in excellent condition. It can scarcely be said in spite of the undoubted abundance of this species that it did any real injury to any well established tree.

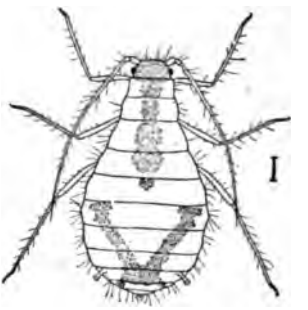


Fig. 1.
Maple-louse; wingless form, enlarged; original.

Quite a different tale there is to tell about the species attacking fruit trees, which were favored by the same weather conditions. On apple and cherry, tips began to curl and twist early in the season, and soon the cherry trees in some sections of the State had almost every tip tightly closed over a mass of filthy black lice exuding "honey-dew" upon which a soot-fungus found a favorable opportunity to grow. The fruit was affected in some cases, and the growth of the tree was checked in all. Here also the warm, dry weather of late June changed conditions for the better, although it could not undo the injury already caused.

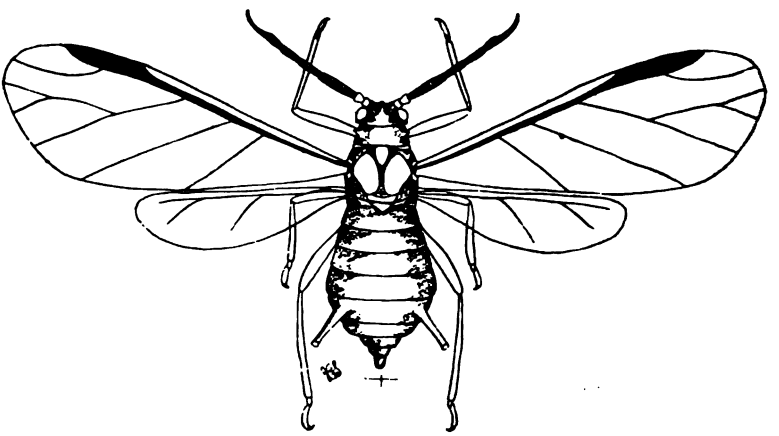


Fig. 2.
Melon-louse; winged migrant, enlarged.

On apple trees the injury was even more serious, because here the fruit was more generally involved. A great deal of the crippling of apples which was variously charged later in the season, was really due to the early check caused by plant lice and soot-fungus. In a few cases applications of whale oil soap were made on young trees to check the development of the insects so as to prevent the dwarfing of the new growth, and these applications were, as a rule, successful. Applications to old trees were not encouraged because of the difficulty of reaching the insects and the uncertainty of satisfactory results.

Unless a spray can be directed into the curled up tips from behind, and with sufficient force to get into the shelter formed by

them, the results will not pay for the expense of treatments. In some cases the attack was so bad that the tips were killed and the appearance was that of blight. It is not improbable, in fact, that this disease did complicate matters, finding easy entrance into the plant tissues already weakened by plant louse attack.

Plums suffered to a less extent; but this may be due to the fact that there are very few commercial plum orchards remaining in New Jersey. In the brief record of the Experiment Orchard it appears that my own prune crop was materially reduced by plant louse attack.

That favorable turn of weather in late June which put a period to the work of the species already mentioned, favored the development of an altogether different lot of species, and for the first time in several years the "melon louse" became offensively obvious. There was nothing to prevent migration in late June and early July, and very soon thereafter complaints began to come in. At the field meeting of the State Board of Horticulture at Tennent, in late July, a number of Camden and Gloucester county growers referred to this as a serious matter, and there is no doubt that the crop was cut nearly if not quite 50 per cent. in some sections, and, locally, even more. Very little attempt was made to check the insect, and very few of the growers realized the serious nature of the attack until the period for the most effective treatments had passed. The practical exemption from injury enjoyed for several years last past had imparted a feeling of safety, which proved disastrous in 1909.

After the late cabbage had been set out and was well started, it was observed that plant lice, which are always present to some extent, were becoming unpleasantly numerous and the necessity for applications was quickly recognized. Here there was no doubt and the suggestions were always prompt and uniform in response to inquiries. The insects yield readily to applications of whale oil soap suds at the rate of one pound in five gallons of water, provided the application is made with sufficient force and in a fine spray. To appreciate the importance of this recommendation it must be remembered that the cabbage leaf surface is waxy, and that the plant lice have a waxy powdering. Both of these shed water readily, and any application made in large globules with little or no force, will simply roll off without wetting either leaf or lice.

But a fine, forcible spray wets the surface and the insects as well, enabling the material to exert its real insecticide effect. The secret of success against these insects lies not in the material employed but in the method of application. It is not intended to suggest that whale or fish oil soap is the only effective material that can be used. Oil emulsions or tobacco extracts may serve quite as well, but the method of application must be the same in every case. This is another of those cases where it is quite possible for two individuals to use exactly the same material, at the same strength, at the same time, with totally differing results due to the method of application, which is rarely mentioned in the records of experiments made.

Where so many species in one group function as first-class pests, the tendency is to neglect the minor injuries caused by other similar pests; hence the really serious injury caused by other species of plant lice was little regarded during the past season. The black peach aphis, for instance, was almost as troublesome as it was in 1908; grape vines were quite generally infested, and, broadly speaking, wherever plant lice are at all troublesome, the season of 1909 afforded abundant opportunities for their development.

One of these minor attacks was especially marked in some nurseries and in private grounds where spruce trees are grown. It was the spruce bud-louse, *Adelges abieticolens,* which caused a really serious monetary loss to many individuals. It is an insect that forms a gall-like capsule near or on the terminal shoots of spruce, checking growth and in some instances killing the growing tips. This is a species that has been carefully studied in Massachusetts and elsewhere, and Mr. R. A. Cooley's recommendation to spray in April, with whale oil soap suds, one pound in two gallons of water, has not been improved upon.

No other branch of the general agricultural industry has been worse hit by plant lice than the nurseries, and it has cost some of the growers of ornamental plants many hundreds of dollars to keep their stock in good condition during the year.

breaks of this insect occurred at a number of points in Mon-
, Burlington and Cumberland counties during the middle
tter half of June. In most
a considerable area, sev-
quare miles, was covered by
festation, but there were also
isolated reports.
ew cranberry bogs were at-
and somewhat injured, but
nost every other case the
originated in wheat fields,
ence wandered into timothy
rn fields. When inquiries
d the office, farmers were
d to, and generally did,
across the line of march to
corn and other threatened

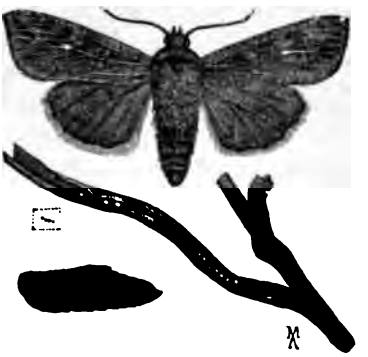


Fig. 3.
Army-worm moth, the eggs laid in grass blade, and pupa: about natural size. From Div. Ent. U. S. Dept. Agric.

This method proved effective in every case where properly
and after the beginning of July nothing more was seen of
rms.
insects did not become really conspicuous until full grown,
any of them entered the ground to pupate when the some-
ounger forms started on their march. The usual Tachinid
es were so abundant on the caterpillars seen that I felt safe
ring farmers that they had nothing to fear from later
and this conviction proved well founded.

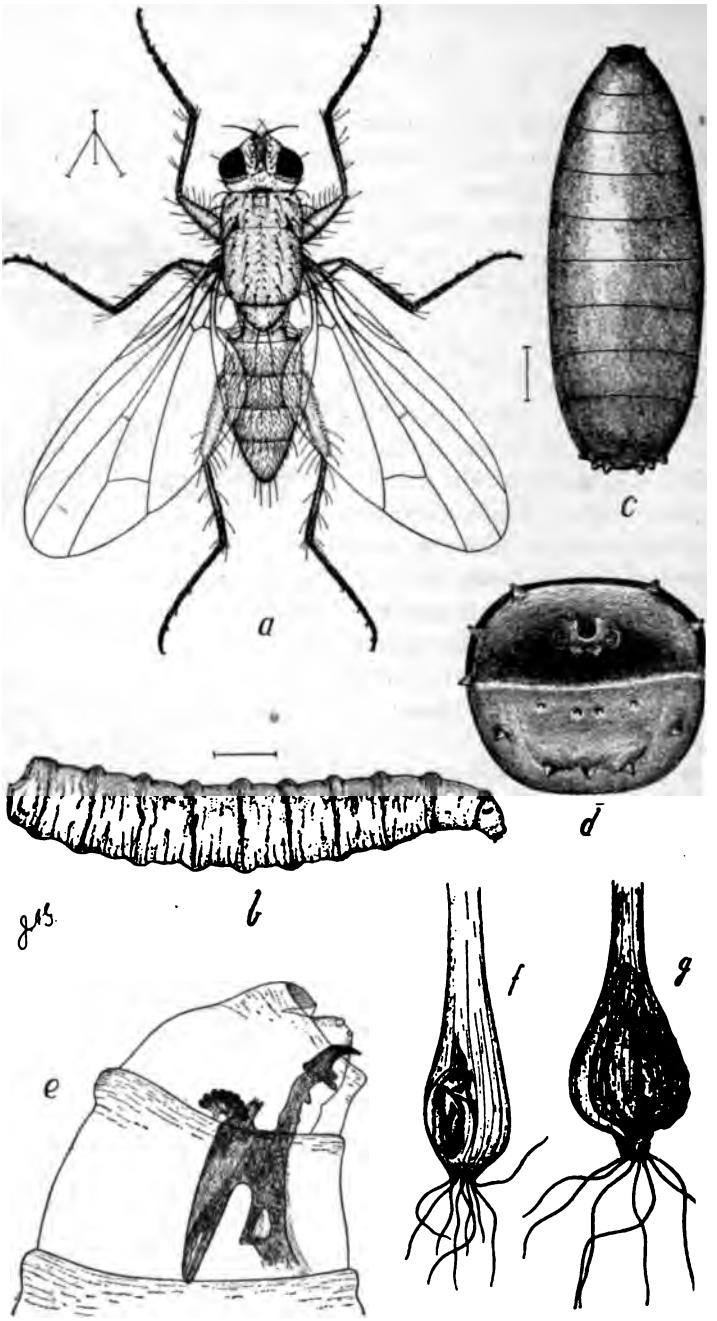


Fig. 4.

Onion-maggot fly: *a*, adult; *b*, larva; *c*, puparium; *d*, anal spiracles; *e*, mouth of la *f*, *g*, infested onions; all much enlarged.

ROOT MAGGOTS.*

Observations upon root maggots were continued as in previous years. In the field the insects were observed where they had previously been noted in injurious numbers, namely, the Riley and Black farms at Mercerville near Trenton, the Seabrook place near Husted, and the Stemler farm at Matawan, while conditions were also noted in other localities. Flies were bred in the laboratory and outside for the purpose of obtaining more definite information concerning the number of broods, &c.

The account of field conditions is followed by a brief record of breedings and experimental work.

MERCERVILLE CONDITIONS.

On both the Black and Riley farms the cabbage plants were set during the first week in April, and on May 5th it was found that oviposition had begun, while the capture of a few flies of both sexes about the plants indicated that it was still in progress. Eggs were found about a number of the plants and in the Riley patch specimens of the red mite, *Trombidium sericium,* were noted—sometimes two about a single plant, in the work of destroying the eggs. In this patch several specimens of a cynipid parasite were also observed. In most cases they were moving actively upon the stems of the plants, but one was noted below the surface. Hatching of the eggs had also begun, as several young maggots were found in the material collected. Onion flies were also observed about the young onion plants.

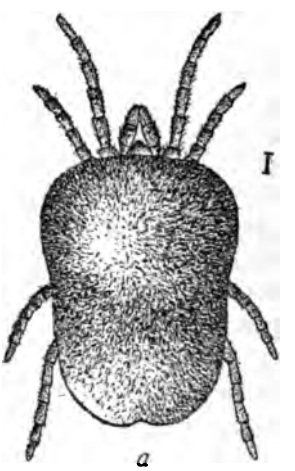
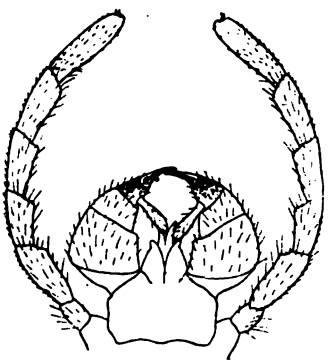


Fig. 5.
Red mite preying on eggs of cabbage maggot; much enlarged: original.

May 10th, when Mr. Grossbeck visited the Riley patch he reported that very few sound eggs were to be found, although a

* This work has been done chiefly by Mr. E. L. Dickerson under the general direction of the entomologist.

number in a collapsed condition, evidently destroyed by the mit were noted. Fewer mites were observed and only a single pa site, but the latter was "fully half an inch below the surface the soil." Very few flies were seen, but this may have been d in part to the strong wind that was blowing. May 14th Mr. Gro beck found that oviposition had apparently ceased. Only thr sound eggs were found, mites were very scarce, while neith flies nor parasites were observed. A number of maggots h hatched, about 25 per cent. of the plants appearing to be infeste although by only a few maggots on a single plant.



b

Fig. 6.

Mouth structures of red mite; enlarged; original.

When this patch was examine May 24th, a large number of t plants was found infested. As l fore only a few maggots were fou about a single plant, and none show evidence of wilting. The magg were generally two or three inches l low the surface, mostly full grow and in three cases the cynipid pa site was observed associated wi them.

In the Black patch, on many of t plants the effect of the insects w quite evident, while an examinati of the roots of others showed that st more plants were infested. The m jority of the maggots were well developed, a few quite small, ar several pupæ were already noted. The maggots were well down c the roots, and as many as twenty-five could be found on some plant These conditions were undoubtedly due to the fact that within th past day or so carbolic acid emulsion had been used. The appl cation had killed a number of the maggots, while the rest ha evidently been driven down or into the roots by it.

June 8th, an examination of the Black patch showed that seven of the cabbages had been destroyed, while the development c others had been checked. The development of the insect wa favored here, as the plants had been cultivated less than usual an no application was made until the maggots were well develope In the Riley patch, on the other hand, no application had bee made, and, while the number of eggs was evidently greater tha

in the Black patch, yet there were fewer maggots present, with the result that on this date maggot injury on cabbage was not so great as in the Black patch. Apparently this difference was due to the beneficial work of the mite in destroying the eggs of the maggot. Very few maggots were then present, but puparia were found, generally away from the roots, and five to six inches below the surface.

The radish and onion plants on the Riley place were practically free from infestation, save that where radishes were growing between rows of onions, the latter were badly infested. These were so planted with the idea that the insects would attack the radishes and thus the onions would be protected. This is evidently of no value, and in any event could apply only to *A. fusciceps,* which infests both radishes and onions, but seems to prefer the former.

A few maggots, some partly and some full grown, were found infesting wild radishes on this date and they were probably the last of the first brood.

July 8th, when conditions were again noted, it was found that on both the Riley and Black farms the insects were breeding freely in wild radishes scattered pretty well over both places so that these wild radishes were the natural breeding place for the insects at this time. In feeding, these maggots burrowed along the surface, rarely into the root, the center of which was as a rule very tough. Sixty-five examples were collected and of these three were pupæ, two of which were found in the maggot burrows; forty-eight were fully developed maggots, fourteen about half grown and three about a third developed. Evidently some of the first brood of maggots had matured and the resulting flies had oviposited about the wild radish plants. Not all the first brood maggots, however, had reached maturity, for a search in the soil about the cabbage plants on the Black place showed that puparia were still present, as many as seven being taken about a single plant. At this time no maggots could be found breeding in the cabbage stumps.

September 21st the places were again visited. On the Black farm it was found that a harrow cultivator had been run through the cabbage patch, apparently some time previous, and the cabbage roots had been dislodged. This made it difficult to determine the exact position of any particular plant to find pupæ, and a search for the latter was without result. The old stumps, however, had sent out several sprouts and had become somewhat covered with

soil. The result was that places suitable for the breeding of the had been formed and in several instances where the youn sprouts were covered with soil, or the stumps had become a lit softened by decay, maggots were found. Some were very sm and had recently hatched while many were nearly or quite f grown. In no case were maggots found working through the tou centers of the roots or stems. A search was then made for adu which resulted in the capture of ten males, and two females, *brassicæ*. More were seen and still more might have been obser and captured had not the place been partly overgrown with wee

On the Riley place turnips were being grown and at this d were of medium size. In these considerable infestation was not more particularly in the younger ones, and the maggots were about same condition of development as on the Black pla Breeding was also in progress in the wild radishes, where a sea for adults resulted in the capture of two males and six fema all *brassicæ*.

On October 11th, adults could still be found in the fi although in small numbers, while some of the maggots had app ently pupated. In the Black cabbage patch most of the magg had disappeared from the cabbage stumps, although half a do small ones were found. On the Riley farm it appeared that great majority of wild radishes had been or were infested.

CONDITIONS ON SEABROOK PLACE.

March 18th, this place was visited and maggots were fo breeding in onions which had been sown last season for purp of raising seed. After the tops were cut off the onions were to serve the same purpose the present season. It was noted du the winter that the plants appeared to be in poor condition, an examination showed that they were infested with maggots. this date both maggots and pupæ were found. Some of the la were very close to the plant and, looking at conditions as a wh it was apparent that the maggots had developed to some extent even pupated since fall, during periods of warmth.

Certain applications were made on April 15th, and again a w later, and Mr. Seabrook reported that while no flies were seer

the former date, they appeared within the next few days. On May 3d, when I visited the place, it was very windy and no flies were observed, although they were undoubtedly present. The earliest radishes were just being pulled and showed no signs of maggot injury. A week later, however, it became very evident, and when, on May 18th, I visited the place, all the radish beds were badly infested, as were also the cabbage plants. The flies were about gone, very few being observed among the plants. In the onions there was very little infestation, and this may be due in part, at least, to the fact that from the time the onions are set in mid or late March, they are cultivated thoroughly about once a week, the dirt being first thrown to and the next time away from the plants.

On this date, May 3d, the soil was removed from about the cabbage plants, and with it a number of maggots, and a strong solution of carbolic acid emulsion was sprayed about the roots. This did not injure the plants, but apparently killed all the maggots with which it came into contact. The result was, that when the plants were next seen, on June 15th, they had developed considerably, and this had been greatly helped by the fertility of the soil and an abundance of rain.

On the latter date no maggots were found on either cabbage or radish, but a few puparia were in the soil about the former.

In the onions from sets, Mr. Seabrook estimated that about 10 per cent. had been destroyed by the maggot, and while most of the maggots had disappeared, some could still be found. Directly under some of the onions which had been infested, puparia were found at a depth of three or four inches. Where the injury had been slight, the onions were outgrowing it, and I was informed that these might be bunched with the green onions; or if injured slightly worse, might be used as dried onions.

A few flies were noted about the plants, so that on this date in this bed, a very few small and some large maggots, puparia and a few flies could be found.

July 1st, the infestation of the onions was over, and all the flies had disappeared. In some radishes sown about May 25th, there was considerable infestation, and, on this date, the maggots were for the most part fully developed. No flies were seen about the radishes. Nothing further was seen of the maggots, save that a

few were noted in some scallion onions on October 7th. But late radishes and turnips were not being grown on account of the liability to infestation.

STEMLER FARM.

March 8th, I visited Mr. Stemler and found that he had piled up a few crates of infested onions in an open shed last fall and allowed them to stand there during the winter. They had thus been exposed to the atmospheric conditions, yet a glance showed that the insects were in a healthy, active condition. A handful of infested onions taken from the top of the upper crate gave two small and two large maggots and seven puparia, some of which were light in color, showing that pupation had recently occurred. Thus the insects had passed through the winter in a partially developed state, and, apparently, development continued during warm periods.

June 12th, an examination of conditions here showed that the onions were infested worse than the past two or three years, and in this connection it is of interest to note that while Mr. Stemler destroyed all the infested onions which he had kept in separate crates, a neighbor had thrown out a similar lot within 200 yards of his patch. This may have been his source of infestation. Several remedial applications were made, as noted under experimental work, but for various reasons these were not successful. Maggots were found in some of the plants, while from others they had disappeared and evidently pupated. No flies were observed, although they had apparently been there recently, as a few evidently sound eggs were noted.

CEDARVILLE CONDITIONS.

May 17th, it was found that little had been seen of the root maggots on the onions to date, either in the untreated patches or on those where applications had been made. In some years some of the growers have had half of their onion crops destroyed by the maggot. The onions here are usually set in March and pulled in July, and the present season certain growers had been using kainit at the rate of 300 to 400 pounds to the acre.

RICHFIELD CONDITIONS.

June 7th, this place, which is south of Paterson, and a large rucking center, was visited, and, as elsewhere, many of the grow-rs had been troubled with root maggots. By this date the insects ad about disappeared and only on one of the places visited were hey noted. Here a number, mostly fully developed, were found bout some cauliflower, and associated with them in small numbers he maggots of another fly.

Another species of Diptera—*Pegomyia vicina*—was noted here, n this date, working in the beet leaves. The flies, which some-hat resemble those of the cabbage maggot save they are reddish n color, were flying in numbers about the beets and oviposition as in progress. The eggs, in clusters and from one to a dozen, ere always placed on the underside of the leaves, in which the aggots burrowed between the upper and under surfaces. One f the growers stated that the insects damaged the leaves to such n extent one year that it was impossible to bunch the beets. These aggots are troublesome for the most part early in the season, and everal had tried remedial measures as noted under experimental ork.

REMEDIAL MEASURES.

As stated in the report for 1908 there has been no record of the rength of carbolic acid recommended for insecticide work, and nce it was desirable that experiments with carbolic acid emul-on should be made with acid of a known strength. For this pur-se a 95 per cent. acid was obtained, from Barrett Brothers of hiladelphia, and five gallons were sent, early in the season, to essrs. Stemler, Riley, Black and Seabrook, each, who agreed to e the material as suggested, namely, in the form of an emulsion ade up of one pint of acid, one pound soap and one gallon of ater, and for application, one part of this, diluted with fifty parts water.

On the Seabrook place the material was applied as recommended April 15th, and again a week later. Flies, which appeared to those of the cabbage maggot were noted in the patch between ese two dates, but unfavorable weather conditions prevented any

immediately succeeding application, with the result that wh examined the plants on May 18th, considerable infestation noted about the roots. On that day the soil was removed and it a number of maggots, and then carbolic acid emulsion, n stronger than anything recommended, was applied, made u ten quarts of acid, ten pounds of soap and ten gallons of w and used at the rate of one gallon of this to ten gallons of w This killed the maggots wherever it came in contact with t and apparently did not hurt the plants.

On the Stemler place the carbolic acid emulsion was ap May 8th, to rows of young onions, just as the latter were ma their appearance above ground and, on account of weather c tions, the next application was not made until May 17th, and two more at week intervals, with the result that when the was examined on June 12th, no difference was noted between treated and the check rows.

On the Black farm they had intended to spray when the in made their appearance, but for various reasons, together with fact that they had not observed any infestation, the applic was delayed until after the middle of May, when maggots been found. Then the emulsion was applied with a driving s and a Vermorel nozzle about the plants, with the result th penetrated to some extent and killed a number of the mag But there were many which escaped and it appeared as if t were either driven further down or within the roots, as an un ally large number were found in the latter place when the pl were examined a few days later.

It appears that the carbolic acid emulsion is an effective kil agent when used at the proper strength. But it must be be early and used frequently enough to reach the maggots.

Carbolic Acid Fertilizer.—This was the material which made up last year by Mr. Merchant, who was then with the (sumers' Fertilizer Company. As noted in the Report for 1 it consists of the fertilizing ingredients which would be used the grower, with an addition of carbolic acid. The Consum Fertilizer Company continued the manufacture of this mate under the name of the "Dokkenwadel Insecticide fertilizer," Messrs. Stemler and Seabrook gave it a further trial this year.

Mr. Stemler applied it at the rate of 400 pounds to the a working it in the soil in late April, just before the onion seed

sown, and also applying it along other rows after the onions had sprouted, on May 8th and 17th, and again twice at week intervals. In early June no difference was noted between the treated and check rows, both being equally infested.

Mr. Seabrook applied the material at the rate of 200–400 pounds per acre, first on radishes and onions, using it April 6th, before the seed was sown, and working it into the soil, and then following it with two more applications on the radishes as a top dressing on April 15th, and again a week later. On these latter dates the material was also applied to cabbage as a top dressing and worked into the soil about the plants. An examination made in June showed that the material had not been effective.

Apterite.—This material is manufactured by the English firm of Wm. Cooper & Nephews, with a branch office in Chicago, and they recommended it as effective against underground insects. Accordingly some of the material was sent to Mr. Seabrook, to test it as recommended. On April 6th he applied it at the rate of 300 pounds to the acre, broadcast, and worked it into the ground well. On the same day he sowed onion and radish seed on the treated ground. An examination in May showed no difference between treated and untreated areas, both being equally infested.

Lime.—At Richfield one of the largest growers said he had formerly been troubled considerably with the onion maggot, but for the past few years he had given the ground a good top dressing of lime and worked it in well just before setting or sowing his onions, and since doing this he had not been troubled with the maggots on this crop. It is not apparent just how this was effective against the insect.

Gas Tar.—Several of the growers at Richfield stated that their cauliflower was formerly much damaged by the maggots, but that for the past few years they had been using gas tar and sand on the cabbage and cauliflower with good results. The material was used at the rate of one part of gas tar to twenty-five parts of sand thoroughly mixed, and a good handful of the mixture sprinkled about each plant. The gas tar cost about $1.25 a gallon, and that amount was sufficient for 1,000 plants. They had found that an increased amount of the gas tar was injurious to the plants, and that the material should be applied not later than the end of the first week in May, and earlier if possible. On June 7th, when I visited this locality, two plots where this material had been used were in fine

condition, while one on another farm where no application l
been made showed considerable infestation.

Clean Culture.—The necessity for keeping down wild cr
ferous plants was more strongly emphasized than ever during
past season. In July, and again in September, more wild radis
were found infested with maggots than at any previous time. 1
the first time maggots were found breeding in cabbage stumps, ;
hence the advisability of removing the latter after the heads h
been cut is obvious.

BREEDING NOTES.

In the Report for 1908 it was noted that, in October, magg
had been found infesting the turnips on the Riley farm at Mer
ville. Some of these were collected and pupated in the laborat
where, between October 20th and 27th, four male and five fen
brassicæ, as well as thirty-two parasites, emerged. A few m
came out during November and December, but, owing to the p
becoming a little too dry, no more matured thereafter.

About the middle of November pupæ from this same lot w
placed in the ground in my yard at Newark, to keep them in
near natural conditions as possible, and to enable me to watch th
develop. Some of the pupæ were placed on the surface, some at
normal depth of three or four inches, some at a depth of tw
inches. For some reason part of these pupæ died. The spri
on the whole, was cold, save for a warm period in April, and
cages were covered in early May. Flies began emerging early
the month, and between May 7th—15th inclusive—from all ca
a few flies were obtained, representing both *brassicæ* and *fuscic*
After the latter date no more flies emerged.

While this record does not give exact data, it is interesting
showing that both *brassicæ* and *fusciceps* may pass the winter
the pupal stage and emerge during early May for a period
several days—perhaps half a month or even longer; that b
pupæ covered deeply and those at the surface produced flies,
well as those at a normal depth.

During the present season several lots of flies were bred in
laboratory, and pupæ were again placed in the ground in my y
at Newark, to obtain as nearly a natural development as possi
In the laboratory the maggots or pupæ were placed in sand

battery jars, and the sand moistened from time to time and kept in as natural condition as possible. Some of the rearings obtained from these jars were as follows:

Maggots infesting cabbages at Husted, collected May 18th, produced from June 4th—8th inclusive—five male and eleven female *fusciceps.* and nine parasites; and September 17th, eleven male and seven female *brassicæ,* and two male and two female *brassicæ* on October 4th.

Maggots breeding on radishes at Husted, collected May 18th, produced from June 4th to June 9th, eight male and eleven female *fusciceps.* and from August 17th to September 22d, five male and five female *brassicæ,* and another female October 2d.

Maggots infesting radishes at Mercerville on May 24th, produced one male and two female *fusciceps,* on June 11th and 18th, respectively; August 25th to September 17th, five male and one female *brassicæ;* one male and one female *brassicæ* and two parasites by September 22d; and one male and one female again on October 4th.

Maggots breeding in cabbage, and some pupæ collected at Mercerville on May 24th, gave between June 3d and 11th, six male and four female *brassicæ;* August 25th to 30th, six male and eleven female *brassicæ;* September 17th, six male and six female *brassicæ;* and from then to October 15th, two males and one parasite.

July 29th, more pupæ were collected from about the infested cabbages, and as there had been no breeding during the summer on these plants, the pupæ were those of the maggots infesting the plants in May. Between August 17th, when the first of the flies emerged from this lot, and October 9th, when the last (to date of writing) came out, there were thirty-one males and fifty-one females, all *brassicæ.*

From maggots breeding upon cauliflower in June, at Richfield, flies were obtained in June, August and September, and all were *brassicæ.*

From the material placed in the soil outside, very few adults have been obtained during the present season. The record of rearings is as follows:

Pupæ from soil about infested cabbage plants at Mercerville, collected June 8th, gave one male and five females June 16th and 17th; three males, July 16th; three males and three females, Au-

gust 14th to 26th; and one male, September 3d. Some of these emerged from a normal depth and some from a depth of eight inches and all were *brassicæ*.

Maggots found breeding in wild radishes at Mercerville on July 8th, produced between August 26th and September 1st, three male and eight female *brassicæ*.

FRUIT PESTS.

SAN JOSE SCALE.

There was an optimistic tendency among some fruit growers early in the season of 1909 in reference to this insect, a belief that its day had passed, and that serious injury was no longer to be feared from it. There was an apparent basis for this feeling in some few localities, where the insect did not do well in 1908, and, it may be said in a general way that 1908 was not a very favorable season for the species. But the reverse was the case in 1909, and any ground lost last year was fully regained in this. The truth is that wherever the insect has been persistently and intelligently fought, there is less trouble than ever before; where no active measures have been taken, matters are as bad as ever or even worse. The extracts from the crop bulletin, scant and imperfect as they are, will bear eloquent testimony to this.

On the other hand, the nurseries of the State, where life and trade depend on freedom from the pest, were never cleaner than they are now, and this is also true of the orchards in charge of up-to-date growers.

As a matter of fact there is no longer any excuse for suffering from this insect. The lime and sulphur mixtures on peach and plum, the miscible oils on apple and pear have been demonstrated as effective remedies when intelligently and thoroughly applied, and at a cost quite within the range of legitimate orchard expenditure.

It must be realized from the very start, however, that reliance must be on the unaided efforts of the grower; that nature has not as yet done anything to materially lessen the burden, and that a seasonal check due to unfavorable weather conditions is *not* a sign that the days of virulent infestation are over. That in time the

ect will find its place in the general scheme of tree and plant wth and will cease to be the menace that it is at present, I sin-ely believe; that this time is near at hand, I find not the slight-evidence. The grower putting out a new lot of trees, that banks on anything other than his own efforts, is likely to find himself the losing side before his orchard has paid for its planting.

The experiences of the past year have brought out nothing new her in New Jersey or elsewhere in the United States. The com-rcial preparations now on the market bid fair to supersede the ne-made mixtures almost entirely, and the competition between nufacturers has brought prices down to a level which is reason-e and furnishes a more uniform mixture at a price scarcely ater than that of a home-made preparation.

CODLING MOTH.

This insect was unusually abundant and troublesome during the son of 1909 and chiefly because the second brood was unusually ge. In the pine barren re-n of the State two broods normally well marked, but n here many individuals of first brood do not develop; y lie over in the larval ge until the next spring, ile the majority develop o moths and provide for late summer worms. In Delaware valley region the ond brood is not nearly so ll marked or abundant, and haps the majority of the væ developing in July lie r, unchanged until the ring following. During the mmer of 1909, the opposite s true, and the majority of the larvæ completed their develop-nt, forming an unusually large second brood.

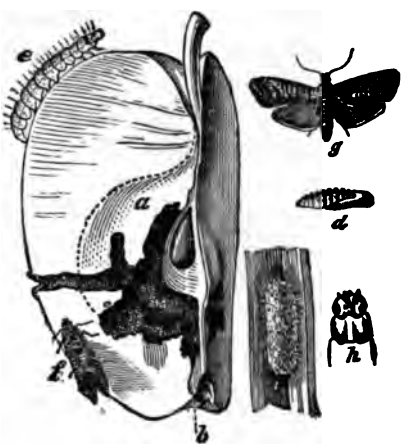


Fig. 7.

Work of codling moth larva: *a*, borings in apple; *b*, location of egg; *d*, pupa; *e*, larva; *h*, its head; *f*, *g*, moths; *i*, cocoon.

In the Piedmont plain or red sandstone region the second brood fragmentary in ordinary seasons, only exceptional larvæ com-

pleting their transformations and producing late wormy apples or pears. In 1909 the number of larvæ developing into moths in midsummer was unusually large, and wormy apples, in consequence, were abnormally plentiful even in sprayed orchards.

North of the Piedmont plain one brood is the rule, but even here, in 1909, late or second brood larvæ were present in large numbers.

There was no unusually large hibernating brood from 1908. In fact, I wanted some moths early in the season and instructed Messrs. Grossbeck and Dickerson to use every opportunity to gather larvæ and pupæ while I personally kept a lookout as well.

We all found material unexpectedly scarce. Parasites and birds seemed to have made almost a clean sweep and empty cocoons were the rule. As the result of a whole day's work in Burlington county, Mr. Dickerson turned in less than half a dozen larvæ in early April. It is fair to say that only unusually well hidden larvæ escaped the birds and that on an ordinarily smooth trunk very few specimens could survive.

July 13th, Mr. Dickerson found at Moorestown that larvæ were spinning up on the trees and some had already pupated.

July 21st, he found at Woodstown more larvæ than pupæ, but plenty of both on old unsprayed trees. Adults from this lot began to issue July 28th.

July 27th, at Glassboro, he examined the burlap bands in an apple orchard, which is always well sprayed for the first brood and where the trees are also banded to attract the larvæ so as to prevent the development of a midsummer brood. Mostly, larvæ were found here because the bands had been recently examined, and no more than a dozen larvæ were found under any one band on even the most heavily loaded trees. A very few recent pupæ were found, however, and most of the larvæ pupated promptly in the laboratory. The first adult out of this lot emerged July 28th, and the last was recorded August 13th.

July 29th, larvæ and pupæ were found at Mercerville near Trenton, and empty pupal shells indicated that moths of the second breed were already on the wing.

In my own garden I found the infestation after midsummer to be by far the worst of any in my experience, and the percentage of wormy apples at harvest larger than agreeable. Sources of infestation from unsprayed trees are near by, but heretofore the treatment for the first brood has answered every purpose.

In New Jersey, spraying, where it is done at all, is against the first brood only, and in ordinary seasons that is all that is necessary. It would be all that is necessary in any event, were it not for the fact that almost everywhere there are old, uncared for trees, on which the insects are permitted to develop unchecked, and that gives the supply that makes its way into the better kept orchards.

Banding the trees to attract the larvæ in July and killing them off at intervals of a week has been recommended in a previous report, and is practiced with good effect by some growers. It is a practice that should be general south of the red shale line.

As to methods of treatment, little can be added. Arsenate of lead is increasing in favor constantly, and one pound in twenty gallons of water, thoroughly applied with all possible force, answers every purpose. Some yet prefer the Paris green and obtain satisfactory results from it. If done thoroughly and just when the fruits are well set, a single spraying will answer. In a mixed orchard where varieties vary in time of blossoming more than a week, two applications are better—one when the earliest variety is just right, the second when the latest variety is in the best condition. Success is more a matter of judgment and thoroughness than of material or machinery, though these should also be well selected and fit for the work to be done.

WASP INJURY.

A very curious and interesting complaint was received in early October from Bergen county, where the large European hornet or wasp, *Vespa crabro*, was charged with attacking ripe apples and eating into them to such an extent as to render them unsalable. Although I did not myself see the insects at work, the description of the attack was so detailed that there seems to be no doubt in the matter. The fruits selected were the finest and most nearly ripe, apparently without flaw or blemish, and the insects ate a circular hole an inch and a half in diameter and about one-quarter of an inch deep, on the softest side. The tissue was not eaten but chewed and sucked, the dry fragments being rejected. Two samples were sent me, and the appearance was as though the insects had used their own full length as the diameter of the hole and worked down until they were satisfied, keeping the depression at an even depth.

Baldwin, Banana and Bismark apples were attacked, and on a small Banana tree one basket out of three was ruined.

This *Vespa crabro*, or European hornet, has not been with us for many years, and has been rare rather than otherwise until recently. It is much larger than our largest native paper-making wasps, and it makes its nest in hollow trees or similar sheltered localities where it is not easily found. It uses green wood in its paper-making operations and gets it from a variety of shrubs. Mr. W. T. Davis has noted it as attacking lilac bushes and chewing them up seriously. Should these insects become much more numerous it may be necessary to take measures to get rid of them.

PEAR PSYLLA.

The record of this insect for 1909 is much like that for 1908. Its injuries are localized, and wherever the trees were thoroughly treated during the early or late winter with one of the miscible oils, good results were obtained. Good results were also obtained by heavy applications of lime and sulphur driven against the trunk with force enough to fill cracks and crevices and get under loose bark scales. Many specimens were doubtless sealed up in this way where the mixture did not actually reach them. Bordeaux mixture containing a great excess of lime was of decided benefit in one orchard, the formula being two and one-half pounds copper sulphate, eight pounds lime and fifty gallons of water. It was the lime in both these mixtures that was the effective material, and the frothy covering over the psylla nymph was insufficient to protect it from the action of the caustic that was sprayed on early in the season soon after they made their appearance. The lesson of thoroughness was again learned in following these applications, for everywhere the results were in proportion to the care with which the work was done, and the completeness with which the application was made.

It was curious to note how local the distribution of the insect remains, and how, even within a single extensive orchard, certain sections are much worse than others, irrespective of variety.

PLUM CURCULIO.

This insect has been remarkably abundant throughout the State during the past season, and has been much more than ordinarily injurious to peaches. Mr. Blake first called my attention to this point, and especially noted that the most serious injury was done in orchards where the crop was light.

Heretofore the actual injury done by this insect to peach has been deemed negligible, and, indeed, where there was a good set, even this year the thinning caused was not beyond the real needs. Nevertheless, there was a very decided puncturing of fruits, and much of the peach drop was charged to it. It does not seem so certain that the mere puncturing of a young peach necessarily results in a drop, as it does almost invariably with plums, but it seems quite certain that when punctured fruits drop, larvæ very generally develop afterward. It is also certain that fruit rot finds in these punctures convenient points of entrance, and that fruits so attacked are the first to develop disease.

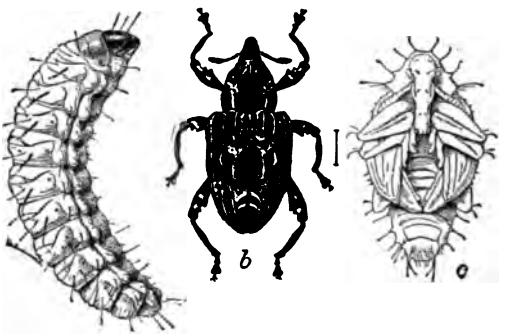


Fig. 8.
The plum curculio: *a*, its larva; *b*, the adult beetle: *c*, the pupa; enlarged. From the Div. Ent., U. S. Dept. Agric.

Throughout the season examinations were made of fruits showing egg punctures on tree and dropped fruits, and in almost all cases fruit firmly attached to the tree showed no developing larvæ, while the dropped fruits with egg punctures as uniformly showed larvæ present where egg punctures were on the fruit. It should be distinctly understood that not all dropped peaches showed egg punctures, and I do not believe that, in many cases, the curculio puncture caused the drop; but where fruits in which eggs have been laid drop from any cause, larvæ develop. There is no doubt either that, in a small percentage of fruits remaining on the trees, larvæ develop, and where this occurs the fruits will drop. It is

further certain that, where fruits are at all generally attacked, they are marred to some extent even where rot does not develop.

June 21st, in a Glassboro peach orchard, twelve fruits showing curculio crescents were plucked from two trees. In four of these larvæ had hatched from the eggs and eating had started, but in three out of the four the larvæ died before the burrow had penetrated much below the surface. In one fruit two developing larvæ were found.

Twenty-nine fruits showing egg punctures were picked from the ground beneath the trees; every one of these showed one or more burrows, and, in all save five of them, larvæ were actually present, more or less well grown.

June 24th, in a Merchantville orchard, nine peaches were picked from trees, all of them with egg punctures. In six cases there had been no development of any kind; in two the egg had hatched, a short burrow had been made, but no larvæ could be found; in one case a half-grown larva had burrowed half around the fruit, yet it was still firmly attached.

Forty-three fruits showing egg punctures were gathered from beneath the trees, and in all of these there had been larval boring and most of them contained one or more grubs nearly half grown.

July 1st, at Vineland, in a young orchard just coming into bearing, thirteen fruits were picked from the ground, and all of these showed larvæ or borings.

In an older orchard, nearby, the dropped fruits under four trees were examined:

Tree 1	9	peaches—	3	sound,	6	with	larva	or	borings.
" 2	22	"	5	"	17	"	"	"	"
" 3	11	"	8	"	3	"	"	"	"
" 4	12	"	7	"	5	"	"	"	"

On a fifth tree five punctured fruits were picked, but in none of them was there any boring or larval development.

On my own trees there was practically no curculio puncturing of peaches at all, and that was not because there were no beetles, because almost all the prunes and many apples were attacked.

It seems certain, however, that under some conditions the peaches may suffer from curculio attack, and it is certain that beetles in great numbers develop in the dropped fruits. A method

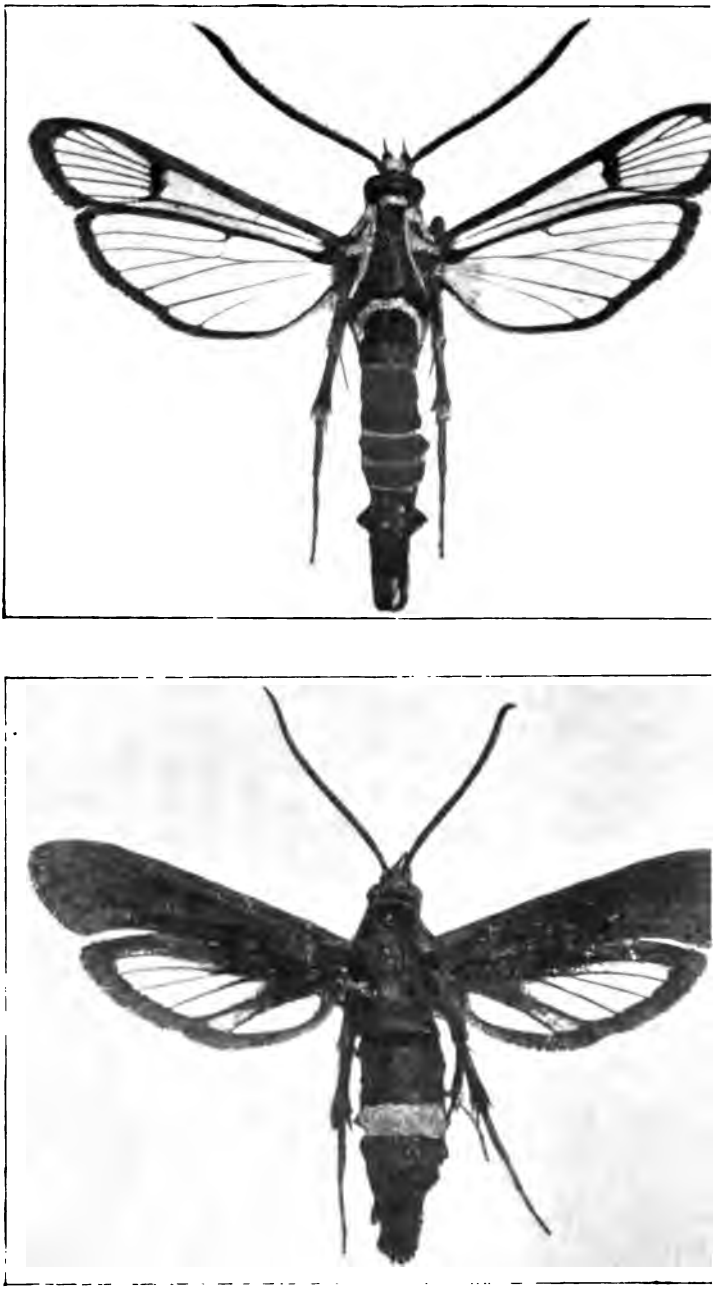


Figure 9.

Parents of peach borer, much enlarged; male above, female below.

of checking this development is, of course, highly desirable, and it seems fairly certain that by spraying with arsenate of lead we can secure this check.

The insect develops in early summer, goes underground to pupate and emerges as an adult beetle in July and August. It then goes into hiding and does not reappear until early the spring following. Then the beetles feed for a time, mate, and the female begins her task of laying eggs. For each egg a crescent is cut, and the task is thus a somewhat lengthy one and not completed until well along in June.

For best results the trees to be protected should be sprayed with arsenate of lead, one pound in ten gallons of water, just before the blossoms are ready to open, to kill as many as possible of the feeding adults. They should be sprayed again as soon as the first egg puncture is noted, and the effort should be to cover the fruit as completely as possible so that, in cutting its crescents, the insect is almost bound to get a dose of poison. At this time one pound of arsenate of lead in fifteen gallons of water will answer, and another spraying of the same character should be made about a week or ten days later, to cover more completely the rapidly enlarging fruits. This sort of treatment has proved effective in some localities and served in my own case to protect a prune on which, in past years, the insects harvested the entire crop. On this point the record of the Experiment Orchard should be consulted.

PEACH BORERS.

These insects are always more or less troublesome in the light soils of South Jersey, and they form a distinct menace to the life of young orchards. Much complaint came from Vineland early in the season, and on May 11th Mr. Dickerson examined one orchard of six-year trees that was then being "wormed." Its owner had wormed them in the fall and spring of each year, and never seemed to be able to get rid of the insects, finding small and large ones at apparently all seasons. He was advised to protect his trees with newspaper wrappings, and after consultation with Mr. Blake it was decided to use a few of the trees in his experiment orchard to test the effectiveness of this newspaper work locally.

May 26th, Mr. Dickerson and Mr. Grossbeck wrapped (60) trees, twelve (12) each of Greensboro, Waddell, Mt.] Reeve's Favorite and Carman. The trees were two years old grown excellently well and the dividing rows between the var were chosen. The rows are twenty-four trees long and the *eas* of the first row was wrapped, then the west end of the second the east end of the third row, &c.

The newspapers were ordinary local issues, poor in tex folded to make a wrapper six to eight leaves in thickness, and was twice wound about the trunk and tied at the top with a cord. The trees had been "wormed" just before by Mr. I and were supposed to be borer free. The entire orchard of tw seven rows was infested, but slightly more on the eastern side less on the Reeve's Favorite than on any other variety.

In a younger orchard—one year—the trees were in appar sound condition and on two dividing rows, Alton and Edge Beauty, eleven and twelve trees, respectively, were wrapp opposite ends of the row.

August 19th, having been advised by Mr. Blake that the were growing so fast that the strings on some of the wrap had given way, I sent Mr. Grossbeck down to examine, reti report.

Row 1, Greensboro, ten wrappers were retied. Four of had been burst at the bottom by exuding gum from cuttin borers making their way out, and, in one case, a pupa skin sticking through the paper. No larvæ remained and no veloped pupæ.

Row 2, Waddell, five wrappers retied. Only one of these been burst by borers; the others broken at top and ragged.

Row 3, Mt. Rose, nine wrappers retied. Three of these burst at bottom by gum or borers; the others were burst and ra at top only.

Row 4, Reeve's Favorite, seven wrappers retied. Two of were burst by borers, the others at top by growth.

Row 5, Carman, six wrappers retied; only one burst by bo Mr. Grossbeck suggests here that mice or other rodents may had something to do with tearing some of the wrappers.

Of the smaller trees about half were retied; the breaks in case due to rapid growth and not, in any instance, to borers.

examination of older trees in an adjacent orchard indicated that most of the insects had transformed and only straggling larvæ and pupæ remained.

An interesting fact, developed in this connection, is that out of sixty trees that had been most carefully examined for worms, eleven yet remained infested—some by more than one larvæ, though the exuding gum seen came, in some instances, from wounds made in cutting out borers. Another fact is that newspaper wrappings are not sufficient to prevent the emergence of borers or the change to adult. In this particular tar-paper, if available or safe, would be better.

September 30th, Mr. Grossbeck took off all the wrappers and examined the wrapped and some unwrapped trees closely.

Row 1, Greensboro. Four trees had small borings about one and one-half inch from top of paper; but no larvæ were found. No new borings at base of ground or below.

Row 2, Waddell. One tree had a small boring, without larva, just below the top edge of paper. None at surface of ground or below.

Row 3, Mt. Rose. Exactly the same record as for Waddell.

Row 4, Reeve's Favorite. Three trees showed new borings, one of them with two fresh lumps of gum just within the slit where the old paper had burst.

Row 5, Carman. Two trees showed new borings, one of them with a small larva, and, in one instance, two openings in a slit in the paper.

Of the younger trees, seven showed signs of new borings, all just below the top edge of the paper.

Of the unwrapped trees more than 50 per cent. of those examined showed new infestation, and in all cases at or below the surface. On the papered trees not one new boring appeared below the surface and none were more than one and one-half inches below the top of the paper except where the eggs were laid through a slit or tear. These borers were therefore easily seen.

One notable feature was the very small size of the larvæ seen, and the fact that in most cases no larvæ were found in the borings beneath the paper. Indeed that was also true of the other new borings found.

In order to find the time of development and thus to determine the best time to put on wrappers, collections were made at Vineland July 14th, and twenty cocoons were found. Plenty of larvæ of all sizes and no empty pupal shells. Adults began to emerge July 15th and continued to appear until August 24th.

July 26th, another collection was made at Vineland, and more than half the insects were yet in the larval stage; some of them no more than one-third grown. Most of them, however, just about ready to pupate. In the laboratory, adults began to emerge July 28th, and continued until August 19th.

July 29th, a collection was made near Trenton, and about fifty pupæ were brought in. There were a few larvæ yet remaining, but on the other hand there were also some empty pupal shells. In the laboratory adults began to emerge July 31st, and continued to August 24th.

The conclusions from these observations are—first, that worming in early fall scarcely pays because the larvæ are so small that the majority of them will be missed, no matter how careful the search; second, that even in early spring a goodly number of larvæ will escape the observation of a trained man; third, that paper or other protective wrappings need not be placed before July 1st, and that the worming at this time will yield the best results; fourth, that worming may be profitably continued until the end of July.

I do not mean to suggest that it is good policy to do no worming until July; indeed this would mean allowing the larvæ to complete their injury without check; I mean only that prior to that date it is almost impossible to make a complete job. I should advise a very careful examination in mid May to get rid of all reachable borers at that time; but I would not advise that the work be then discontinued.

It is intended to continue this experimental work in these orchards another season on a much more comprehensive scale and with other means of protection.

Rose-Chafer Experiments.

There was less complaint of rose-chafer injury than in any of ıe three or four years last past, and it would seem as if the crest ' the increase wave had passed. Nevertheless, locally, there were enty of specimens, and with the courteous co-operation of Mr. eorge A. Mitchell, an experiment was made in the small vineyard ' the Training School at Vineland.

This consists of only a few rows of Ives and Concord, and on ay 31st arsenate of lead at the rate of one pound in five gallons ' water was applied part of one row of res, and part of one ıw of Concord. Part ' one row of each va- ıety was left as a heck, and the balance f the rows received he usual sprayings vith Bordeaux, three pounds of arsenate of lead being used in each fifty gallons of Bordeaux.

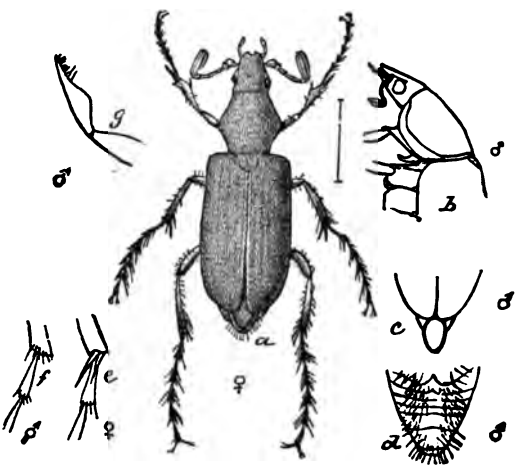


Fig. 10.

The rose-chafer: female adult with details of structure; enlarged. From Div. Ent., U. S. Dept. Agric.

June 5th an examination was made which showed no beetles on the vines treated with the one-to-five mixture, and only a few where the three-to-fifty mixture was used; but beetles were not nearly so abundant as in recent previous years. A little later the beetles were collected from the vines by one of the men in charge, and he reports more beetles from the two checks than from all the rest of the rows together, with no appreciable difference in favor of the one-to-five rows.

June 14th I looked over the vines myself and found that on the whole the Ives were much more injured than the Concords, sprayed or unsprayed; that the outside rows and the ends of all rows were much worse than the inner portions of the yard.

The vines sprayed with the one-to-five and the checks are both on the outside rows, and there was very little difference between them. In fact, the Ives vines sprayed with the one-to-five mixture were the worst injured of all, and worse than the check at the other end of the row. On the Concords the check vines had more beetles and were worse injured than any others of this variety, and as between the one-to-five and the three-to-fifty there was nothing to choose. It is, perhaps, unfortunate that one of the center rows did not also get a one-to-five application; but the result proves, at least, that where the beetles come on in great numbers they will do their destructive work before any poison can take effect, and that the arsenate of lead does not act as a repellant. Very little foliage was eaten except on the check vines, the injury being estimated by the condition of the fruit clusters.

The collections and inspections made demonstrate that the beetles are less abundant on the sprayed than the unsprayed vines after the first flight has settled down, and no doubt many specimens were killed, but not until they had eaten a full meal of blossom buds in every case.

Late in the month, when the season for the insects was practically over, Mr. Dickerson examined the vineyards of the Vineland Grape Juice Company, where all the vines had been regularly sprayed with Bordeaux mixture, plus three pounds of arsenate of lead to each fifty gallons of mixture.

Here, also, the beetles had been present, in small numbers only, and mainly on the outside rows adjacent to grass lands. No injury whatever was done on the main part of the vineyard, and only a little on the outer rows.

It is probable that in large vineyards a thorough spraying of the outer rows will serve to protect the main body of the vineyard, although I would advise the addition of three pounds of arsenate of lead to each fifty gallons of Bordeaux from the time the first beetle appears to the middle of June at least.

Strawberry Insects.

Very heavy plantings of strawberries in Burlington, Atlantic and Cumberland counties have brought to the front the injuries caused by a number of the known pests attacking them. Chief

ıong these are the strawberry weevil and the strawberry leaf ller. Both of these species have been under observation for a ar or two last past, and the work was somewhat more sys- matically carried on during the season of 1909. Enough ma- rial has been gathered to warrant the publication of a bulletin the subject, which will render unnecessary more than a mere ference to the matter here.

A curious occurrence was noted near Port Norris, where on ked land along the river a ground beetle, normally predaceous character, attacked the ripening fruits by eating out the seeds. ıe species involved is known as *Amara exarata,* and this is the st time, to my knowledge, that it has been known to cause ouble. Allied species of ground beetles have done similar mis- ief in other States, but it usually follows some abnormal con- tions and is temporary in character. In this instance the land ıd been in grass, reeds and other weedy vegetation growing in ıe rich, river bottom land, and had been cleared and put into rawberries only the year before. In the mass of rank vegetation ese beetles had found excellent conditions for their development; ıt in the subsequent scant covering of strawberry plants their ormal prey was absent, and the beetles followed a taste which is ot an entirely unusual one in the group under certain conditions.

Cranberry Insects.

Cut worms were again locally troublesome on cranberry bogs, ıd were controlled by applications of arsenical poisons. During ırly summer I visited several bogs in Cumberland county, and ound that there are at least two and probably three species at ıult to some extent, and that all of these differ from the New gypt species reported last year. No attempt was made to bring ıy of these species to maturity and the only study was made was determine the identity of the cranberry flea beetle.

CRANBERRY FLEA-BEETLE.

In the report for 1908 I described in a general way the character of the injury noted on the bogs, and concluded that the offender was probably a flea-beetle, *Systena hudsonica,* which had been found doing similar work in Massachusetts.

From information obtained I believed that the insects would be found at work some time in June, and on the 26th of that month I sent Mr. Dickerson to Mays Landing to look over the Makepeace bogs. No trace of insects or injury was found at that time, and not until late in July did Mr. Makepeace notify me that he had observed traces of the characteristic feeding.

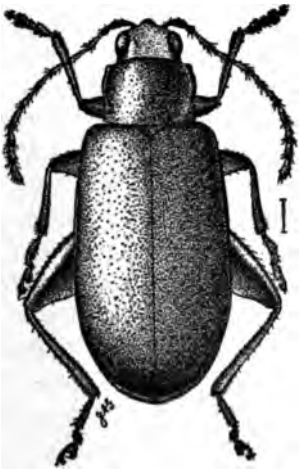


Fig. 11.
Red-headed cranberry flea-beetle; much enlarged. Original.

August 1st, I went on the bogs myself, and had no difficulty in capturing a series of the culprits, a *Systena* as I had supposed, but the species was *frontalis* instead of *hudsonica,* the former having a red head, while the latter is uniformly black. Both sexes of the beetles were present and they were busily engaged in feeding, but they were very local and not overly abundant anywhere. It was along the ditches that they were most plentiful and they were present on the weeds as well as on the cranberry plants. No trace of the early stages was found and all the injury seems to be done by the adult.

The beetle varies considerably in size, not over one-quarter inch at one extreme and not much more than half that at the other. It is black in color except for its red head; oblong and a little flattened in shape, and jumps and flies readily. It eats the soft tissue on the upper surface of the leaf, rarely attacking the under side, and it never eats entirely through the tissue. Sometimes only a few mouthfuls are taken from a leaf; sometimes a large part of the surface is scraped. As a rule, feeding begins near the middle of the leaf and extends toward one side, rather than down the middle line.

As to the injury caused, that depends altogether upon conditions. On young vines scantily covering the ground, the hot sun and the heat from the sandy surface tends to kill the injured leaves even when there is only a small surface attacked. When the plants overhang a ditch, there, also, a tendency to scald will be found, and, in every case on a scalding bog, these eaten points give ready entrance to the fungus and soon the work of the disease obscures that of the insect. On healthy vines in a well established bog, the amount of eating done is absolutely without ill effect.

The method of control is obvious: the insects feed openly, usually on the upper surface and on the upper shoots, which are easily within reach of even superficial spraying. Therefore, apply arsenate of lead, one pound in twenty gallons of water, as soon as the first sign of injury is noted, covering thoroughly all the area where the insect is known to occur. Where bogs are sprayed with Bordeaux mixture, the addition of one pound of Paris green to every 100 gallons of Bordeaux at a spraying between July 15th and 25th, will probably be sufficient to prevent any material injury. As it is on young bogs that the insects are most likely to be troublesome, the special treatment with arsenate of lead will probably be the one most usually resorted to.

Where these beetles that thus appear on the cranberry bogs in late July and early August pass their early stages, I do not yet know; all that is known of the species of this genus is that the larvæ are underground feeders on roots of weedy plants.

SHADE TREE PESTS.

THE ELM-LEAF BEETLE.

The prediction made in the Report for 1908, that the elm-leaf beetle promised to be more abundant in 1909 than it was in 1908, was most completely verified. Not in the twenty years that I have been in the State have they been so plentiful or so destructive.

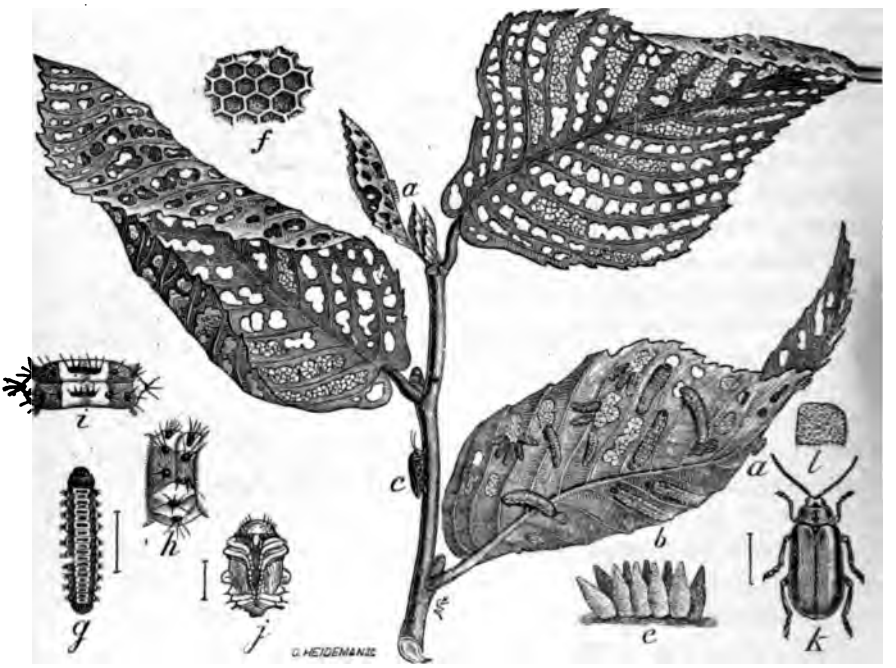


Fig. 12.

Elm-leaf beetle: *a*, *a*, egg-patches on leaves; *b*, larvæ feeding; *c*, adult; all natural size; *e*, egg mass; *f*, surface of egg; *g*, larva; *h*, *i*, details; *j*, pupa; *k*, beetle, and *l*, its elytra; enlarged. From Div. Ent., U. S. Dept. Agric.

Not only in cities and towns but along the country roads the elms presented a pitiful sight from early July to late August, and in most places to the end of September.

Even before the first of May isolated examples of the beetles began to come out of their winter quarters, but it was not until the warm spell beginning May 10th, that they made their appearance

in numbers. On May 12th, the day was ideal and the beetles simply swarmed out of their places of concealment. On a small shrubby tree, the tip of which could be reached from the ground with a cane, I instructed Messrs. Dickerson and Grossbeck to collect the beetles and count them. They were jarred into an inverted umbrella, many of them flying away; but during the day no less than 8,400 examples were taken by actual count. It is a fair estimate that not less than 10,000 of the beetles were on that little tree during the day. Its position next to a vacant stable in which the beetles found excellent winter shelter, accounted for this terrific infestation.

The college grounds have 115 elms of medium or large size, all of which were thoroughly defoliated in 1908 and made a good start in 1909. Spraying began May 13th, with a Gould 200-gallon tank sprayer, and was practically completed on the 14th, two 100-foot leads of hose and Bordeaux nozzle being employed to do the work. Three brands of arsenate of lead were used—Grasselli, Sherwin-Williams and Vreeland—all at the same strength, one pound in fifteen gallons of water. Growth was rapid, and to protect the new foliage, a second spraying was begun May 26th, at the rate of one pound in twenty-five gallons of water. It was interrupted by rain on the 27th and not finished until June 1st. The first eggs were noted on unsprayed trees May 18th, but on the sprayed trees only isolated patches were noted much later. Larvæ were not noted until June 6th, but there may have been a few out some days earlier. From this time the difference between the sprayed and the unsprayed trees became continually more marked, the College trees standing out in ever greater contrast against those surrounding which were not treated.

As between the different brands of poison, there was little to choose. The strength first used was excessive and meant to check the beetles promptly to prevent egg laying. The second application was meant to hit the young larvæ from eggs that might be laid and that was equally effective for its purpose. It was curious to note, toward the end of June, the defective spraying work. Here and there a branch had been missed, and on the largest trees the extreme tips had not been properly reached. All these places began to stand out brown and scraped against the green surroundings, and demonstrated how little the beetles had moved after they once began feeding.

June 30th, the larvæ were crawling down the trunks in lar numbers and the first pupa was noticed. Next day pupation beg with a rush, and for days the larvæ continued to make their w down to the ground. The first adult of the summer brood w noted July 8th, but beetles did not become numerous for seve days later, nor was there much appearance of feeding. It w feared that these new beetles might center on the sprayed trees feed, since there was little else for them to attack; but apparen the poisonous coating was still effective, for little additional jury was noted.

Toward the end of August showers broke the continuous droug and the trees most completely defoliated began to put out n leaves, only to have them thoroughly riddled almost immediat by the insects that were seeking a meal prior to entering win quarters. About this time letters began to come in from hou holders who found the beetles entering dwellings and feared inj to fabrics, and not until September had they disappeared.

During the entire summer weather conditions were ideal— the beetles—and no trace of disease appeared. The brood in hib nation is fully as large as that of 1908, and the prospects for 19 are for even more serious injury. If these prospects carry fully, it will mean the death or serious injury of many large tre for quite a number of them did not put out a sufficient second c of leaves to carry them through the season in good condition. some parts of New England matters were even worse than in N Jersey, and trees are already dying or dead. The matter is serious one, and should be thoroughly understood by the citiz of the State before it is too late.

That there is no impossibility in this suggestion is demonstra by the experience of the communities that fought the insect t year.

The city of Newark had eight gas sprayers at work and spray all elms and many other trees on 560 miles of street frontage w arsenate of lead. The results were all that could be desired, a single tree being defoliated, according to the report of the sec tary of the Shade Tree Commission. In East Orange two pow sprayers did equally effective work, the difference between c trees and those on private grounds being sharply marked. In Su mit, a 200-gallon tank machine, with a hand pump, did all t was needed and protected the magnificent trees of that place.

small tank sprayer did excellent work for Roselle, and there is no community so small that it is not able to afford the amount necessary to protect its trees.

Besides the municipal work done, there were many private enterprises at work. At New Brunswick about 150 trees were sprayed once, by a local nurseryman, with very good results, and, in a number of other cities and towns equally satisfactory work was done.

In this connection it should be remembered that it takes fifty years to make a good elm. Defoliation for three years in succession will destroy it.

The fact that the beetle is absolutely single brooded at New Brunswick was again demonstrated, but it was also found that at Ridgefield, in Bergen county, on the northward extension of the Delaware valley faunal region, there was a partial second brood of considerable extent.

It was also noted that spraying may be effectively done at any time before the larvæ have hatched from the eggs and that up to the middle of June good results may be had. The ideal time is just as soon as the beetles begin to feed; in city work, where many hundred or even thousands of trees must be treated, work may begin with the first full-grown leaf about May 1st and continue until June 15th.

EGG PARASITE OF ELM-BEETLE.

In the report for 1908, a brief account was given of the attempt to establish the little parasitic wasp, *Tetrastichus xanthomelænæ* Rond., in this country, as a check to the further increase of the elm-beetle. Only a few specimens were received by me and at a season when there was little possibility of their becoming established, but it was hoped that better success could be secured in 1909. Dr. Howard had promised to let me have infested eggs when they made their appearance in either Washington or Massachusetts, and he also arranged to have further material shipped in from France. Unfortunately, his correspondent in the latter country died suddenly at the beginning of the season, and no arrangements could be made in time to obtain specimens from other sources. No trace of the parasites could be found where I liberated them in New Brunswick, and the search in Washington and Boston was

equally unavailing. It is by no means certain, however, that this means failure, for the parasites, even if all survived, must be as yet very few in number and so scattered as to be difficult to find. No progress can be reported for the present year, but arrangements for obtaining large supplies from southern Europe in 1910 have been perfected by Dr. Howard, and some of this will come into New Jersey to be placed where better opportunity for establishment can be afforded.

GYPSY AND BROWN-TAIL MOTHS.

During the several years last past I have annually reported the progress of the work against these pests in the New England States, and in my Report for 1908 especially called attention to the dangerous position occupied by New Jersey.

Before that report was actually in the printer's hands a situation developed that was unexpected, and which called for prompt action.

It appears that, during the season of 1908, brown-tail moth became very abundant in some parts of Europe, and among them the nursery stock districts of France. The foreign nurseries are not under government supervision; no care is exercised in selecting stock for the average shipment to America, much of it bought because of its cheapness, and in most cases it reaches the purchaser or distributor in America without passing under the eye of an official. In New York State there is, fortunately, a very complete organization for nursery inspection, and in December or early in January it was observed that some of the stock coming from abroad contained winter nests of the brown-tail moth. The State Department of Agriculture took active measures at once to get track of all stock that had been previously received, and at the same time notified the inspecting officers of neighboring States of the danger.

Unfortunately the funds at the disposal of the State Entomologist, or the Station, put any sort of nursery supervision similar to that carried on in New York State entirely out of question but I communicated at once with all the nurserymen doing other than a local trade with local-grown stock, requesting that they advise me as to their foreign importations already received or expected. From most of them prompt response and cordial cooperation were received, and for several months thereafter there

was a constant rush to keep abreast of the work demanded to examine such of the imported stock as was likely to prove infested.

In early February there was a meeting in New York City of the officials from the nearby States, at which a representative from the United States Department of Agriculture was also present, and at this meeting, which was informal in character, the general conditions were discussed and arrangements were made whereby the inspecting officers of each State might be advised of every parcel of stock passing through the New York custom house into their jurisdiction.

At this point acknowledgment should be made of indebtedness to the New York Commissioner of Agriculture and the Department headed by him. There is no doubt that without the prompt action taken and notice given by them, the brown-tails would have established themselves in several States, and without their courtesy in sending notices of shipments received in New York, it would have been absolutely impossible for me to keep track of the stock coming into New Jersey.

Thanks are also due to the Entomologist of the United States Department of Agriculture for a supply of literature, and for notice of clearances of shipments into New Jersey.

With the assistance thus given, Mr. Dickerson and Mr. Grossbeck examined many parcels of stock and assisted at the unpacking of others, finding a large number of nests containing many hundreds of living caterpillars. The details of this work belong in the report of the State Entomologist. It is enough to say here that in New York, New Jersey and adjacent States over 5,000 active nests were found and destroyed, and that in this work many hundred thousand plants were inspected. Even into the Central States some of these nests were sent, and, worse than all, a batch of Gypsy moth eggs found their way as far west as the Mississippi.

This was bad enough, but matters came yet nearer when a lot of infested plants found their way from Massachusetts into Westchester county, New York. Again the State Board of Agriculture became active, and succeeded in stamping out the infestation completely.

During early April word was received that one of the New England inspectors, passing through New Jersey, had noted brown-tail nests on some trees near a station. This led to a systematic inspection, in which, by the courtesy of Dr. L. O. Howard, I se-

cured the assistance of one of the scouts in the government employ. Fortunately nothing was found, but the whole line of the Pennsylvania railroad in the suspected area was kept under more or less constant supervision during the season.

During the winter a disquieting report was received that the Gypsy moth had extended into the lumbering regions of Maine, and that a carload of lumber intended for New Jersey had been found to contain egg masses of Gypsy moths. On inquiry this was found to be substantially true, and during July I visited the State of Maine and learnt from Capt. Philbrook, in charge of the control work of that State, that about 6,000 square miles of territory were infested by Gypsy and Brown-tail moths combined; that no active State fight was carried on against brown-tails, but that $30,000 had been spent in 1908 and $25,000 would be spent in 1909 in fighting Gypsies. In addition the United States Government contribution toward the same end was nearly as great, so that $100,000 for the two years was nearly correct as the cost of the campaign.

The infestation in some lumbering districts is so great that every lumber pile is inspected before it is allowed to be shipped out. It is, nevertheless, a question whether the insects are not spreading in the woodland despite all this work.

As for the brown-tail, the loss in three Maine townships for the month of July was estimated at $26,000, because the fear of brown-tail rash prevented the coming of the usual summer visitor.

During the latter part of August, I spent two days with Dr. L. O. Howard, on a trip into New Hampshire, inspecting some of the areas infested by these same pests, and learnt of the methods there adopted to prevent the spread of these insects, this work being almost entirely in the hands of the U. S. Government service, under the immediate direction of Mr. Dexter M. Rogers.

Work with parasites and other natural checks is continued in the U. S. Government laboratory at Melrose Highlands, Mass., in co-operation with the Massachusetts State work, now under the direction of Prof. F. W. Rane, along the lines indicated in my previous report.

The danger of introducing these pests into New Jersey has become imminent, and the machinery at present available for preventing it is insufficient for lack of funds available for immediate

work when needed. The supervision of nurseries should be closer, and there should be a closer control of stock shipped into the State than is at present possible.

THE BRONZE BIRCH BORER.

This is an insect that has caused considerable injury in New York State, and forms the subject of a careful study in Bulletin 234 of the Cornell Experiment Station. The parent of the borer is a beetle, *Agrilus anxius* Gory, which is known to occur in New Jersey, but only as a rarity. In my list of 1900, I had only a single record, from South Jersey, and in the last ten years there have been practically no new captures.

It was a matter of considerable interest, therefore, when Mr. Wm. Solotaroff, the secretary of the East Orange Shade Tree Commission, sent me samples for my opinion, stating that they were killing cut-leaf birches throughout that city. A visit to East Orange and a drive through the city confirmed Mr. Solotaroff's diagnosis; almost all the cut-leaf birches, some of them eight to ten inches in diameter, were infested by this beetle, many of them were dying and some were already dead. Evidently the beetle had been at work for several years and the number of holes in the trees showed that they had been present in considerable quantity. Cutting down, we had no trouble in finding larvæ in the more recently infested trees, but when a tree is once dead, the insects have no further use for it.

To determine whether the allied white birches were equally infested, we examined a number of them within the town proper, and several clumps of trees in the outskirts, but in no case did we find any trace of trouble.

In the belief that this might be a local affair, I wrote to a number of other municipalities concerning the matter, and also charged Mr. Dickerson to look, in his nursery inspection work, for traces of the insect. I have also spoken with several landscape gardeners and nurserymen and, except in two municipalities not far from East Orange, no trace of the insect has been found. Always only the cut-leaf variety of the white birch was the victim.

This is one of the borers that attacks perfectly sound, healthy

trees, and there is no way of preventing infestation so far as I know. The adult beetles appear in June, lay their eggs in little notches that they cut into the bark, and the borer hatches a few days thereafter. The borer is long, very much flattened, narrow, the joints well marked and the head part much broader than the rest of the body. It is a voracious feeder and makes very long and very irregular galleries in the sap-wood, eventually girdling the tree. It gets to be about an inch in length by late fall and then bores into the solid wood to the depth of about one-quarter of an inch, forms a small chamber and changes to a pupa, which gradually hardens to a perfect beetle the spring following. The insect, therefore, matures in one season and feeds always under cover. It is beyond the reach of insecticides but is followed by a number of enemies which heretofore have kept it in control under natural conditions in our State.

The only method of dealing with the insect is to cut out every infested tree and burn it, or, at least, strip its bark so as to destroy the larvæ. At present this would not mean the sacrifice of many trees, and it would certainly check its further spread.

HICKORY BARK BEETLE.

This insect has, for some reason, become unusually abundant during the two seasons last past, over a considerable area, but chiefly in the eastern and northern sections of the State. In Prospect Park, Brooklyn, the matter is serious and many trees are dead or dying. In New Jersey, complaints have come chiefly from owners of small estates, where the trees were really ornamental. These beetles work between bark and sap-wood, making upright galleries, on each side of which eggs are laid. The white, grub-like larvæ that hatch from these eggs make galleries extending transversely in the bast, and when the galleries are numerous enough, the tree becomes girdled and dies.

In all stages these insects are apparently beyond the reach of insecticides. The adult beetles feed very little on the foliage, and the larvæ never feed outside of their burrows. Ordinarily the species is kept in check by its parasites and, no doubt, these will regain control in time; but how soon we cannot at present foretell.

Badly infested and dying trees should be cut down, and the wood
rnt. If that is not feasible for any reason, the trunk and larger
inches should be stripped of bark to destroy the brood. Trees
ghtly infested should be stimulated by a free use of fertilizer,
l should be given an open soil about the trunk. If in solid sod,
: it up so as to permit air, water and plant food to get to the tree
ts. The beetles always attack a weak tree first, and every advan-
e that can be given to a tree helps it to resist the attack of these
ects and makes it less attractive to them.

REPORT ON THE MOSQUITO WORK FOR 1909.

REPORT ON THE MOSQUITO WORK FOR 1909

By John B. Smith, Sc.D.

The work during the fiscal year from November 1st, 1908, to October 31st, 1909, was continued along the lines of the preceding years. There was not so much accomplished in the extension of the drainage work because of the very limited appropriation, but there has been more research work and quite a number of experiments were made and completed, while others have begun and await completion when funds are again available. There has been no change in the staff; Mr. H. H. Brehme has had continued charge of the marsh inspections and similar work, while Mr. John A. Grossbeck has assisted me at the laboratory on inland investigations. Miss A. E. Meske has again attended to the clerical work. The demands upon the executive officer have increased steadily; lectures and talks have been asked for in all parts of the State; health boards and local officials have been met and advised, and assistance has been given in the mosquito campaigns carried on by several municipalities. The more important of these matters will be brought out later in this report.

The financial statement is as follows:

Total appropriation				$15,000 00
Drained Area.	*Acreage.*	*Ft. of Ditching.*	*Cost.*	
Dover township	1.744	215,000	$6,300	
Wall township	110	15,000	350	
Sayreville township	290	28,500	500	
Pt. Pleasant borough	100	17,500	400	
Matawan borough	60	5,200	150	
Manasquan borough	240	35,000	700	
Bay Head borough	128	13,600	300	
Elizabeth	...	.....	500	
Raritan meadows	...	32,000	475	
Waverly meadows	...	4,000	100	
Totals	2,672	365,800		9,775 00
Balance				$5,225 00
Mosquito bulletin			$223 30	
Fumigation experiments			316 40	
Cleaning ditches			142 00	
				681 70
Leaving a balance of				$4,543 30

for expenses of administration, which include minor experimer advertising, traveling, and field expenses, which, owing to the tances to be covered and the remoteness of the territory in so instances, were unusually heavy.

No acreage records are given for Elizabeth, Raritan or Waver as this was additional work in territory previously reported. the Elizabeth instance the amount was contributed under the l which permits a municipality making an equal contribution expend the sum under its own direction, and in this case the su was used in widening and improving the outlets.

The total record for work done now stands as follows:

	Acres.	*Feet of Ditching.*
Up to 1907 as reported	15.851	2,215,524
In 1908 as reported	6.669	888,650
In 1909 as above	2,672	360,800
Total	25.192	3,464,974

Natural conditions were much less favorable to mosquito li in 1909 than they were in 1908. There were no excessive spri rains, but on the marshes a series of unusually heavy tides pr vided sufficient water for the ordinary spring broods. This broug out sharply the differences between the drained and the undrain sections and very heavy flights throughout the area south of To River, brought out newspaper stories of mosquito abundan Further to the north these flights were conspicuous by their a sence; although in a few sections there was larval developme where the drainage work had been insufficient or had been int fered with. Later in the season the droughty conditions prov generally unfavorable to mosquito development until August, a from that time until the October frosts, there were plenty of sa marsh mosquitoes throughout their usual range, while there we practically none in most of the drained area.

So far as the salt marsh mosquitoes are concerned in this draine area, it is safe to say that whereas ten years ago 90 per cent. of th specimens seen were of this type, during the season of 1909 th percentage was reversed and the problem has become a local one serious enough in some cases, but now within the power of loc boards of health. Some of these problems and what has been don to meet them will be touched upon under specific locality heading

The story of the work done in New Jersey has been widel

spread abroad, and has brought out the usual crop of inventors with infallible methods of dealing with the problem. Most of them want iron-clad contracts to receive large sums before they will make known their secrets, and with them nothing can be done. Others are ready enough to explain their ideas, which usually involve outlays altogether disproportionate to the results to be obtained, and still others have projects which, feasible enough on a small scale, are totally inapplicable when extensive marsh areas are to be dealt with. The chief objection to most of the projects is that the results are temporary only, and look to the destruction of the insects themselves. They do nothing to interfere with the breeding places, and therefore the work would never end.

Some schemes are based upon natural conditions that cannot be reproduced in New Jersey.

BATS VERSUS MOSQUITOES.

A very interesting suggestion has been made by Dr. Charles A. R. Campbell, City Bacteriologist of San Antonio, Texas. He has observed an apparent relation between the abundance of mosquitoes and bats, and advocates the establishment of bat roosts or shelters to favor the increase of these creatures as mosquito enemies. He presents a number of instances to substantiate his claims, and also suggests that the manure obtainable from his bat roosts would not only pay for their care and construction, but would even prove a profitable investment. It is known that in the west and southwest bats do, under favorable conditions, multiply enormously, and they may be increased even more as suggested by Dr. Campbell. It is also probable that so large a number of insectivorous animals will materially reduce the numbers of mosquitoes and other insects. Unfortunately, the surroundings in New Jersey are not so favorable for bat increase, and these creatures are rare under the best conditions. Besides, with us, their food seems much more diversified and they distinctly favor much larger insects. Nevertheless, the relation of bats to mosquitoes is worthy a further study.

As accessories to the bats the dragon flies are pointed out as important natural enemies, in the larval as well as adult stages. This subject has been thoroughly investigated, and, while there is

no doubt of the usefulness of the dragon flies in all stages, there is a distinct natural limitation to their artificial use, which was discussed by me in the 1904 report.

AZOLLA VERSUS MOSQUITOES.

Quite a different proposition is the suggestion as to the use of the water plants, *Azolla,* to control mosquito breeding in fresh water swamp areas, and possibly in the salt marshes as well. This emanates from Dr. G. Bartmann, of Wiesbaden, Germany, a man of scientific standing, who has made a life study of aquatic life.

Fig. 1.

Azolla caroliniana as it occurs in New Jersey at points where it was introduced; enlarged. Original.

Probably everyone who has spent any length of time in the lowlands of Holland has noted that during the summer the surface of the drainage canals are covered with a dense carpet of green, which gives way as a boat passes along but closes in after it to replace the coating. So prolific is this plant that it can be cleaned off several times during the summer, and this is done by the adjoining holders, who compost it and thus secure a cheap supply of plant-food.

I noted, during my trip through Holland some years ago, that there were practically no mosquitoes in this low region, which would seem especially suited to breed them; but as I was not at that time interested in the subject, I simply noted the fact without seeking the cause.

During the early part of 1909, Dr. L. O. Howard, of the United States Department of Agriculture, visited this same region, and found that as early as mid-May the water of the canals was covered with a complete carpet of green, so close that there was absolutely no chance for mosquito development. From early May until late fall these sluggish and sometimes almost stagnant water courses are kept clean, sweet and free from mosquito breeding by this living cover, which is purely on the surface and never clogs a course or interferes with its use.

When, during the early summer of 1909, I saw a newspaper reference to some work done for the German government, following on the lines suggested by Dr. Bartmann, these matters were brought back to my recollection and I determined to investigate. Dr. Voorhees was at that time in Europe, and I wrote to him to try and see Dr. Bartmann at Wiesbaden; I also wrote to Dr. Bartmann and to others for information and, if possible, for specimens. Dr. Bartmann was not at Wiesbaden when Dr. Voorhees reached there, and in response to my inquiries he offered to come to America, to investigate and to experiment, for a consideration. This consideration it was out of my power to offer, and no help was obtained from Dr. Bartmann.

Fig. 2.
Azolla sp. Received from Kew Gardens and Hamburg; enlarged. Original.

I applied for information to Dr. N. L. Britton, Director of the Botanical Gardens at Bronx Park, New York, and secured his co-operation. He intended to visit Europe in fall and had correspondents already there, from whom he might hope for material. I also applied to Dr. David Fairchild, in charge of foreign plant investigations at the United States Department of Agriculture, Washington, D. C., and he was good enough to add this matter to the commission of Dr. Meyer, then getting ready to sail on other business for the department. Dr. Meyer has not returned at date of this report, and has not sent any specimens.

Dr. Britton succeeded better, and reached Dr. F. L. Stevens in time to have the latter bring with him a small supply of *Azolla* during the first half of August. The supply was so small that I preferred to leave it at the park, where Mr. George V. Nash, the chief gardener, divided it into two lots to grow under differing conditions. The material grew well and flourished but was not planted out anywhere, and Dr. Britton has been good enough to agree to carry it over the winter, ready to plant out in the spring of 1910, provided the Legislature supplies funds to carry on the work.

There is a species of *Azolla* that occurs in the eastern United States and that maintains itself in New Jersey, but does not spread very fast. Mr. Nash was good enough to send me a sample from a pond in Bergen county, and Mr. J. Turner Brakeley sent me a supply from one of his ponds at Lahaway in Ocean county. In neither case was the plant a native, and in neither case has it spread from the point where it was first introduced. Some seasons it does very well, covering a considerable part of the surface; but it stops growth early, much earlier than the European species; nor does it multiply so rapidly. New Jersey is evidently a little out of its natural range, and, while able to maintain itself, the plant does not do well and does not spread naturally.

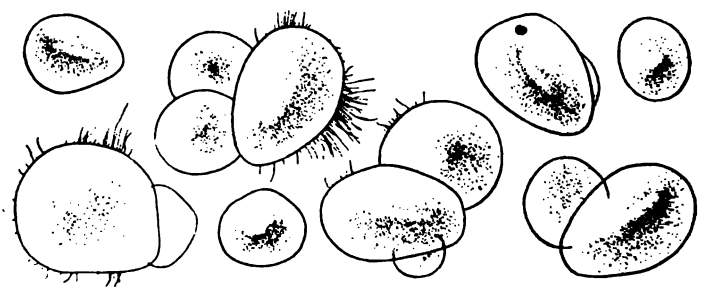


Fig. 3.

The common duck-weed, *Lemna* sp., found on stagnant waters throughout the State.

We have, however, another surface plant that does well and is extremely useful, much more useful than is realized by the public at large. This is the "Duck-weed" or *Lemna* which often covers great surface areas of swampy land, and acres of stagnant water which would otherwise breed mosquitoes. Unfortunately this also makes a late start in spring, and it is not until well along in sum-

mer that it becomes effective as a covering. Nor does it form so complete a covering as the *Azolla* so far as my observations extend.

The subject is an extremely interesting and important one, and deserves a careful study and extensive experiments. At the present time too little is definitely known as to what can be done with the European form, and only pictures of the two species of *Azolla,* and, for comparison, the Duck-weeds are introduced, so that their general appearance may be recognized.

A number of direct killing agents were employed and tested in the field and in the laboratory, mostly by Mr. Grossbeck under my direction. It was observed that many pools showing iron rust remained under all circumstances free from mosquito breeding, and so it was decided to test the effect of sulphate of iron on wriggler development.

SULPHATE OF IRON.

Four battery jars each holding one gallon of water were stocked with 100 larvæ each of *Culex pipiens,* in various stages of growth, 9:15 A. M., August 22d. Some of these began to pupate that same day.

Jar 1 received one-quarter ounce sulphate of iron.

Jar 2 received one-half ounce sulphate of iron.

Jar 3 received one ounce sulphate of iron.

Jar 4 received two ounces sulphate of iron.

August 24th, at about the same hour, the results were as follows:

Jar 1. Over one-half of the larvæ and all the pupæ living and active. The adults later emerged and the full-grown larvæ pupated.

Jar 2. About one-third of the larvæ and many pupæ yet living. All the pupæ later developed and some of the larvæ pupated.

Jar 3. More than a dozen larvæ yet living, all the pupæ had completed their transformations and no more larvæ reached that stage.

Jar 4. Three larvæ and one pupa yet living. The other pupæ had disclosed adults.

At the rate of one ounce to one gallon of water this material is therefore a good, and at double that rate, an effective destroyer of mosquito larvæ and pupæ. Under some circumstances it may be useful on a limited scale; but it will do nothing that petroleum will not do at much less expense.

It seems probable that in those pools free of mosquito larvæ in which the iron rust is present, there is also some other substance or condition that is unfavorable to their development.

TOBACCO EXTRACTS.

Mr. Henry Mason, of Philadelphia, wrote me in early summer concerning a certain cure for mosquitoes and, at a conference with him, he handed me a pint bottle of a preparation which he was free to admit had tobacco as its base, which was supposed to keep off mosquitoes if a small quantity was used on exposed parts of the body, and was supposed to kill wrigglers if poured into water inhabited by them.

As a repellant I tested it personally, and had other members of my family test it. The directions were, a spoonful in a glass of water and wet the exposed surfaces. Neither *cantator* nor *pipiens* paid the slightest attention to it and alighted readily on moistened surfaces. I tried it undiluted with the same effect. It may be useful in Philadelphia, but in New Jersey the insects don't mind it.

The balance of the material, a little less than a pint, was turned over to Mr. Grossbeck for use against larvæ, and he stocked three large battery jars, each containing two gallons of water with larvæ in all stages and pupæ of *C. pipiens* and *C. cantator.*

August 30th, 9 A. M., the extract was equally divided between the three jars, making the proportion about 1 to 50, well stirred, so as to mix thoroughly with the water. At 10 A. M., some of the smaller larvæ became sluggish and at 10:30 A. M. a few sank to the bottom. Up to 2 P. M. larvæ sank in small numbers and then, for a time, the effect seemed to be exhausted; there were scarcely more dead wrigglers at 5:30 P. M. than at 2 P. M.

August 31st, 8 A. M., about one-half of all the larvæ were dead, but most of these were *cantator,* of which few were yet alive, while of *pipiens* few larvæ were dead. No pupæ of either species were effected, and adults were emerging freely.

September 1st, there was no change, and no more were dead on the 2d. Full grown larvæ had changed to pupæ, most of the pupæ had transformed to adults, and the remaining larvæ were active.

New Brunswick city water in late summer contains a large amount of vegetable matter, and tends to foul readily. The addition of the extract aided this, and clots of fermenting matter appeared on the surface late on September 2d, and enlarged on the 3d, so that on one jar an unbroken film had formed, which seemed to interfere with the further development of the larvæ. They began dying gradually, no more pupæ were formed and, on September 13th, only a few larvæ were living in one jar and these had not energy enough left to pupate.

This result suggested experiments with "Nico-fume," referred to in another part of this report, and Mr. Grossbeck stocked two large jars with a mixture of *pipiens* and *cantator* larvæ and pupæ.

September 13th, jar 1 received Nico-fume at the rate of one part to 250 parts of the water; jar 2 received twice as much or at the rate of one part to 125 parts of water. The effect was prompt. Within twenty minutes only a few larvæ and pupæ were alive in either jar, and an hour later only one pupa was alive in each jar. In jar 1, the adult emerged two hours after the application, but was too weak to leave the surface of the water. In jar 2, nothing was alive after two hours.

Obviously this material would stand further reduction, so another supply of larvæ was obtained, and, on September 18th, three jars, each containing one gallon of water, were stocked with larvæ and pupæ of *C. pipiens*.

Jar 1 received "Nico-fume," one part to 2,500 of water. In half an hour practically all the larvæ were at the bottom of the jar, though jerking violently. A few were floating at the surface of the water with head bent under, and, while still alive and responding readily to irritation, were evidently very sick. None of the pupæ were yet affected. After three and one-half hours all the larvæ were dead while the pupæ were yet unaffected.

September 19th there was no change. September 20th two adults emerged, the other pupæ apparently sound. On the morning of September 21st all the pupæ were dead.

Jar 2 received "Nico-fume" at the rate of one part to 1,500 of water. The effect was as before: in three and one-half hours all the larvæ were dead, all the pupæ apparently unaffected. Not until September 20th did the pupæ begin to die, but all were dead on the 21st, and no adults at all emerged.

Jar 3 received "Nico-fume," one part in 750 parts of water. In three and one-half hours all the larvæ and some of the pupæ were dead, and pupæ died off gradually until at 8 A. M. September 20th only two remained. The adults emerged from these during the night of the 20th, and were found dead on the surface on the morning of the 21st. A concentrated extract like "Nico-fume" is therefore an exceedingly violent larvicide, and at the rate of one part in 2,500 of water will answer to kill all larvæ of *C. pipiens*. It may not often happen that this sort of material will be needed for this purpose, but it may at some time become useful to know just what it will do.

SULPHUR.

It was asserted by the owner of a greenhouse, to whom soluble sulphur had been sent, that he poured a small quantity of it into a water barrel swarming with wrigglers, and that it had killed them all. This led to some experiments in the laboratory and also on the Raritan marshes, but no satisfactory results were obtained at any strength.

HYCO.

This is a material prepared by the West Disinfecting Company of New York City, who also produce the Chloronaptholeum which was found useful in connection with sanitary work in some experiments at New Brunswick.

This, it was claimed, was a much more powerful material, and a supply for experimental purposes was sent me by the company, and tests began June 23d, when a satisfactory supply of *C. pipiens* larvæ was at hand. This supply was obtained from three butter-tubs which were sunk into the soil so as to be almost level with the surface, partly filled with mud and vegetable material, and kept more or less full of water.

The experiments were made in large battery jars, with two gallons of water, which was stocked with larvæ of all sizes and pupæ, from those just formed to those ready to transform. The "Hyco" was reduced to a standard strength so as to make a larger bulk, and thus facilitate getting accuracy of proportion.

Jar 1. One part "Hyco," water 4,096 parts. Young larvæ began to die almost at once; in half an hour most of the larvæ were gone, and at the end of three hours all larvæ and most of the pupæ were dead. Half an hour later no pupæ remained alive.

Jar 2. One part "Hyco," water 8,192 parts. Nearly all larvæ were dead in one hour, most of them in half an hour. After three hours some of the pupæ and all larvæ were gone. After eight hours one-third of the pupæ were yet alive and one adult had emerged and died on the surface. Next day everything was dead and no other adult had appeared. There were thirty pupæ and very many larvæ in this jar.

Jar 3. One part "Hyco," water 16,384 parts. Small larvæ began to die in ten minutes, most of the larvæ dead in one hour. After seven hours all larvæ and two pupæ dead; five adults had emerged, two of which never left the surface of the water. Next day three pupæ were yet alive, one of which disclosed an adult which did not leave the water; the others died while the adult was in process of emergence. There were twenty pupæ in this jar and a large number of larvæ.

Jar. 4. One part "Hyco," water 32,768 parts. Well grown larvæ and pupæ only in this jar. In twenty minutes all the larvæ were dead or dying. In three hours half the pupæ were gone, and next morning all were dead, none having disclosed an adult.

This test was made several days after the ones previously recorded, the intention being to reach the ineffective dilution; but the supply of larvæ was small and no further dilution was attempted later, because of the outcome of some other experiments. The comparatively rapid effect of this very dilute mixture may be due to the higher temperature of air and water.

To test the lasting quality of the material, jars 2 and 3 were allowed to stand three days in the laboratory, uncovered, and at the end of that time were restocked with a large lot of *C. pipiens* larvæ in all stages and pupæ. After two hours the smallest larvæ had disappeared, and some of the medium-sized larvæ were getting sluggish. There was little difference between the two jars, and for several hours a few larvæ were gradually killed off. Adults began emerging next day, and in forty-eight hours most of them had emerged, only a few failing to get away from the surface. In jar 2, only a single larva remained alive, in jar 3 there were several.

On the third day everything was dead in jar 2; in jar 3 the active larvæ pupated and all the pupæ had disclosed adults.

July 8th, tests were removed to the experiments tubs which were cleared of all egg boats, filled to a known level, and contained hundreds of larvæ of all sizes and many pupæ. "Hyco" was added at the rate of one part to 10,000 parts of water. In the afternoon all the larvæ were dead but no pupæ were affected and adults were safely emerging.

July 9th, it was found that during the preceding night forty-two egg boats had been safely deposited on the treated water, and, seven days later, July 16th, it was found that the water was swarming with larvæ up to half grown. Obviously the effect of the "Hyco" at this dilution was not a lasting one, and, whatever the killing agent, it was either volatile or was absorbed into the soil or wood of the tub.

July 16th, all the egg boats were removed from three of the tubs, and the fourth, which had dried out, was refilled with water. It was intended to test the lasting effects of the "Hyco," and the tubs were treated as follows:

Tub 1, "Hyco" 1 part, water 1,000 parts.
Tub 2, "Hyco" 1 part, water 2,000 parts.
Tub 3, "Hyco" 1 part, water 3,000 parts.
Tub 4, no treatment.

July 17th, all the larvæ were dead in all the treated tubs; on the surface in tub 2 there was one, and on the surface in tub 3 there were two egg boats, which were removed and the tubs were then left to themselves until July 26th, when they were found swarming with larvæ and pupæ; tub 4 no worse than the others.

July 29th the tubs were all treated with "Hyco," as follows:

Tub 1, "Hyco" 1 part, water 3,000 parts.
Tub 2, "Hyco" 1 part, water 6,000 parts.
Tub 3, "Hyco" 1 part, water 12,000 parts.
Tub 4, "Hyco" 1 part, water 24,000 parts.

July 30th, results were as follows:

Tub 1, all larvæ and pupæ dead.
Tub 2, all larvæ and pupæ dead.
Tub 3, all larvæ dead, pupæ alive.
Tub 4, all larvæ dead, all pupæ alive.

July 31st, all pupæ were yet alive, and on the water in tub 4 was a new egg boat.

August 1st, adults were emerging safely in all tubs.

The outcome is, practically, that at a dilution of one to 30,000 "Hyco" can be relied upon to kill all larvæ except perhaps those just ready to pupate; but that one to 10,000 is the extreme limit of dilution effective against pupæ, and that, even here, adults would probably emerge safely from pupæ just ready to transform.

Under natural conditions no lasting results follow on the treated area, and within a day or two after the application, the water is again safe for mosquito development.

Where, for any reason petroleum is undesirable because of its appearance and odor, or a disinfectant or germicide is needed in connection with a mosquitocide, the "Hyco" is perhaps the best material to use.

To test its availability on salt marshes, Mr. Grossbeck used it on the Raritan meadows on June 11th, on an undrained section containing a number of breeding pools. This is at a point down stream from New Brunswick rather more than five miles as the river runs, and less than five miles from its mouth. At high tides, therefore, the water that overflows the marshes is nearly full strength sea water, and the marshes are typical salt.

The "Hyco" tried at full strength would not mingle with this water, nor would it make a film. Some portions would form floating globules, but the bulk of the material sank to the bottom and rested there. Stirring did not help matters, and the larvæ in the pools were not inconvenienced. This result was anticipated because of information given by Mr. E. Taussig, president of the West Disinfecting Company, and some of the "Hyco" diluted with five parts of fresh water was tried. This formed a perfect mixture with the salt and brackish water, diffusing readily to the very edges of the pools, and the larvæ—*cantator*—very soon began to show the characteristic effects. No tests as to killing strength were made because we had found, by experience, that what killed *pipiens* would kill almost any other larva, and that *cantator* in particular was less resistant than its fresh-water ally.

At New Brunswick the water of the river is so little brackish that even at high tide the "Hyco" mixes readily with it, and forms a perfect emulsion. There is no salt marsh at New Brunswick nor for some four miles down stream.

CELLAR FUMIGATION.

Inspection work during the winter showed that in the cellars of Newark and vicinity, mosquitoes were hibernating in immense numbers, thousands in a single cellar in some cases, and it was suggested by Commissioner Dobbins, who is in charge of the mosquito work done by the Newark Board of Health, that by killing off this hibernating crop the work in early spring might be considerably simplified.

After some consultation a large amount of stramonium was procured in early February, and for a few days the entire force of inspectors of the Newark board was partially employed under the general direction of Mr. H. H. Brehme, who acted as instructor.

The results were not as satisfactory as was expected, and after this became obvious the work was discontinued, to permit of an investigation into the cause. It developed that the irregularities in result were due to the lack of uniformity in the drug. Stramonium, it appears, varies greatly in alkaloidal content, and different parts of the plant will differ in this respect. As the material is stored, unless it is kept in very tight receptacles, it loses in strength and may in time become almost inert.

My original experiments, it appeared, were made with a fresh, full-strength drug, and with the same material the same good results were secured, but the run of the market, it was found, was material that was altogether unreliable. The chemical analysis and other investigations necessary to develop this state of facts carried the season into late March and a temperature that awakened the mosquitoes out of their winter lethargy, and they moved away so readily when disturbed that attempts at systematic fumigation were abandoned.

It will be of interest to note the results of the analyses of six samples of stramonium from as many different sources.

Sample 1,	alkaloidal	content,	0.32 %.
Sample 2,	"	"	0.24 %.
Sample 3,	"	"	0.15 %.
Sample 4,	"	"	0.24 %.
Sample 5,	"	"	0.02 %.
Sample 6,	"	"	0.12 %.

Samples 1, 2 and 4 represent fresh, full-strength material. Samples 3, 5 and 6 are the run of the market, ranging from fair to almost inert, sample No. 5 being of little more value than so much dried hay.

When the stramonium thus failed to come up to expectations, the Culicide was again tested, and that proved satisfactory so far as killing quality is concerned. The objection to it was the cost, the necessity for evaporating over a slow flame and the danger of fire if left unwatched.

Experiments were also made with cresol preparations and some of these proved very effective, but there were objection of some kind to all of them, and the Culicide was on the whole the most satisfactory. The individual cellar costs very little to fumigate, even with Culicide, and for an expenditure of sixty cents almost any average cellar can be cleaned out, but to carry on a fumigating campaign at public expense, in a city of the size of Newark, is almost out of the question.

In fifty pound lots, carbolic acid crystals can be bought for sixteen cents per pound, and gum camphor for fifty cents per pound, and for sixty-five cents about thirty-three ounces of Culicide is obtained, sufficient to fill 11,000 cubic feet of space with mosquito-killing vapor. A cellar eight feet high, twenty-five feet wide and fifty feet long contains only 10,000 cubic feet and few city cellars are as large. The subject will be kept under further observation, but it will be impossible, without funds, to do more than experiment on a very small scale.

INSPECTIONS ALONG SHORE.

It has been the custom each spring, after the heavy storms and tides have subsided, to inspect the areas on which drainage operations have been carried on, to determine what, if any, injury had been caused by winter storms, and what if any additions or modifications of the work were needed.

These inspections are always instructive, calling attention to errors or omissions that are to be regarded in subsequent operations. The work began in March, and was continued along the whole shore area thus far dealt with. Taking the line from north to south.

At *Secaucus,* March 31st, the work has stood well, but some changes had occurred on the meadow that are more specifically referred to under the Jersey City heading. What little work was needed was done by the Jersey City Board of Health.

At *Jersey City,* marsh conditions are in charge of the Board of Health, and they were found in good shape early in March and throughout the season.

At *Point-No-Point,* conditions were thoroughly unsatisfactory, and a full account of the action taken is given under a separate heading. No work has been done by the office on this territory, and, while the improvements now under way will make this entire area mosquito proof, the problem, until this work is completed, is a serious one.

The *Newark* meadows received early attention and, on March 1st, the local board appointed a man for meadow work exclusively. The problem here was complicated by other matters and is also referred to more at length under a special head.

The *Elizabeth* marsh was in very good condition as a whole throughout the season, and additional work done by authority of the local board of health is also specifically noted elsewhere.

The *Linden* meadow was inspected early in April, and was found in general good condition. The Standard Oil Company is putting up extensive plants on this area, but is maintaining drainage conditions and improving them rather than otherwise. There was a little intentional interference, and, in some areas along the Rahway river, some sods were lodged in ditches. This condition of affairs was reported to the local board of health, with the suggestion that about $40 would cover the cost of the necessary work. There was some delay, which allowed a small brood to emerge; but eventually the ditches were cleaned by the local authorities, and no further trouble resulted. The mosquitoes that did get out here mostly found their way to Staten Island, and this gives me the opportunity to say that salt marsh mosquitoes on that territory have been almost completely annihilated. The work done under the supervision of Dr. A. H. Doty is as nearly perfect in its results as anything of that sort can ever be, and the community has benefited greatly from this.

The *Chrome* and *Carteret* meadows were inspected April 2d, and matters were found in fine shape. There was no trace of mosquito breeding, the older sections had most of the sods grown fast,

and the ditches so narrowed at the surface, while maintaining their full width below, that no further trouble need be anticipated. Along the Carteret section on the shores of the Kill and the Rahway river some sods had floated into the ditches and interfered somewhat with the drainage. At a cost of $25 these stoppages were removed and the meadow continued safe thereafter for the summer. It is not likely that any further natural interference with the drainage scheme will occur on this area.

The *Woodbridge* meadow was inspected April 3d, and found to be in good condition throughout. Many of the sods floated into the Arthur Kill during the winter storms, most of the balance were removed by the hay makers or burnt on the marsh. At all events the meadow is now clean, and no work was done on it during the summer of 1909.

Sewaren and *Maurer* were not systematically gone over until June 30th, and at that time matters were found in very general good condition, the universal report being that mosquitoes were few in number and, in comparison with previous years, practically non-existent. The only bad point was at Boynton Beach, where some of the ditches were blocked off by filling part of the marsh area with sand, pumped on by a hydraulic dredge. This created a small breeding area from which one brood emerged early in the season.

Perth Amboy has looked after its own breeding areas from the beginning, and its salt marsh is in excellent condition. There is a little local trouble within the city itself, connected with its sewerage system, and here the house mosquito, *C. pipiens,* was bred in some numbers.

South Amboy never had very much salt marsh breeding area, and the small territory that was ditched in 1907 has remained safe ever since.

The conditions on the *Raritan river* marshes were not altogether satisfactory. This meadow has a considerable admixture of clay in its surface material that makes drainage much slower than in more normal meadows. It is also a very low meadow, and, in times of full moon or spring tides, especially when rain fills the river, a large part of the meadow surface will remain covered for days at a time. As soon as the water falls in the river, most of this surface water drains away, and in a few days a dry level meadow remains, but every shallow depression may, under certain conditions, be-

come a breeding place, and an area that for several years in succession remains safe may, in an abnormal year, breed mosquitoes. Work was necessary here in addition to what had been done before, and that is given in more detail under a separate heading.

The *Cheesequake* creek area of 1,700 acres was in excellent condition when examined April 5th. There had been very little winter blockage of ditches, and an expenditure of $15 was all that was necessary to put the whole into satisfactory shape. Nowhere did the work approve itself so markedly as here, for where, as one of the residents said, they used to eat mosquitoes if they opened their mouth to breathe, the summer passed without any annoyance. This was further evidenced by the number of campers along the bay shore, which far exceeded anything ever before known. Late in the season Mr. Brehme made another inspection and found that some gunners had blocked ditches on the western part of the meadows to flood the "scalds," where they had been in the habit of shooting snipe. On these "scalds" many pools were forming and a full brood of larvæ was on deck. Some adults had also issued and these I noticed later in Matawan. The blockages were not serious, however, and Mr. Brehme removed them at once, allowing the water to run off, and destroying the brood.

It was decided, however, that a little extra drainage was desirable in the Raritan township section, and 28,500 feet was put on the 290 acres at a cost of $500. This area was visited several times during the season by parties who had known it in years past, and could not credit the change as a permanent one. The following letter is characteristically phrased, but expresses the fact:

"189 HIGH ST., PERTH AMBOY, N. J., August 6th, 1909.

"*Mr. John B. Smith, State Entomologist, Trenton, N. J.:*

"DEAR MR. SMITH—Although I have not the pleasure of your acquaintance, I am not going to let *that* prevent me from patting you on the shoulder and saying '*Good* boy, and more *power* to you!'

"Here is a fifth of *August* gone, and no *mosquitoes* in or around Perth Amboy *yet!*

"A few weeks ago I visited Morgan (Cheesequake), and neither saw, felt nor heard a mosquito. *Campers* there tell the same tale.

"To-day I spent half an hour (6:30 to 7:30 P. M.) at Crow's Mill creek, two miles up the Raritan, where the late 'Dr.' Goodridge lived in summer, and found *no mosquitoes.* The caretaker told me that they *used to swarm* there, which I *know* to be a fact. They were *awful.*

"In conversation with my friends here, I find the cause of this blissful state of affairs attributed to your intelligent and systematic efforts.

"I write to express my personal appreciation and gratitude for the abatement of the intolerable pest, and to assure you that the public gives the credit of it to John B. Smith, Entomologist.

"Should you visit Perth Amboy, look me up, and let me feed you at the Packer House.

"Very truly yours,

"Tel. 32-W. JAS. LAWRENCE KEARNY."

The *Marquis creek* area was found in good condition April 27th, and remained so throughout the season, requiring no work of any kind.

The *Cliffwood* and *Matawan* meadows were found dry and free from mosquito breeding April 12th, but some sods had found their way into a few of the ditches during the winter. To prevent trouble these were removed at a cost of $10, and that was all that was needed here during the summer. It was further found that an area of sixty acres, which we had believed safe, was, under certain conditions, a mosquito breeder, and the sum of $150 was paid to put in 5,200 feet additional of ditching.

The *Keyport, Union* and *Lorrillard* meadows were inspected April 13th, and as a whole were found in good condition. There were some sods in some of the ditches and these were removed at a cost of $10 for the three areas. This cost will not be repeated because the ditches have narrowed at the top during the season and the sods have very generally grown fast.

One unsatisfactory area with a few larvæ was found on the Keyport meadow. Here a land company had begun to lay out a plot, running streets into the marsh without much regard to the drainage conditions, and an area of about 100 feet square was turned into an ugly breeding pool of a very temporary character. The local board of health was advised of the condition of affairs and the measures to be adopted were suggested. There was no later inspection to determine whether the suggestions had been heeded. In the latter part of September a general inspection along this bay shore area showed everything in general good condition, and practically no mosquitoes flying on any of the marshes.

At *Atlantic Highlands* conditions were excellent on the marshes throughout the season, but, late in summer, there was some complaint. Mr. Brehme investigated this matter in September, and found that the trouble was due to *C. pipiens,* which was breeding in quantity in a number of large pools in the town itself. The area drained for improvements just outside of Atlantic Highlands

proper is in excellent condition, and, with a little active work by the local board of health, the town can be completely cleared. At all events marsh mosquitoes are not now in fault there.

The *Shrewsbury river* area was inspected April 22d, and found to be in good condition. It was so maintained throughout the season by local associations, and the surroundings about Pleasure Bay, which a few years ago no one would touch, are now utilized as bungalow sites—between twenty-five and thirty of these structures, ranging in cost from $5,000 to $30,000, being in construction at one period during the season. The mosquito work in this region has paid heavily, and the cost of maintenance is not great.

Between Atlantic Highlands and Beach Haven no work had been done previous to the fall of 1909, and the work then done is separately recorded.

At *Beach Haven,* three days were spent during the last week in April, between Barnegat City junction and the new inlet. This work has now stood three winters, and Mr. Brehme's report was extremely gratifying. All the filled areas are as perfect as they were the day we left them, and many acres of breeding territory have been permanently eliminated. Whatever of the sand filling washed into the crevices of the brush base was replaced by the blowing from the beach and sandhills and is now firmer than ever. The ponds that were cut in the undrainable basins are practically as good as on the day when they were made. The barrels remain in the same position and the banks are firm and clean. No sand oozes up from the bottom and there is no vegetation growing in them. The ditches connected with these ponds are as good as the day on which they were made, and drain the territory perfectly. Most of the ponds had still a good stock of fish in them and some had more than were put in. In other words, they have not only maintained themselves through all conditions of winter frosts and summer drought, but have actually bred and multiplied. In some of the ponds the fish had been killed off by the turtles, which are very plentiful and, perhaps, the frogs may have been to some extent in fault.

In the ditched area matters were almost equally good, but there had been the inevitable interference by careless hay makers. Many of these marshes are owned by non-residents who sell the privilege of cutting hay to some contractor who has no interest in the matter except to get the hay off as quickly and cheaply as possible,

without regard to the condition of the meadow. Filling a ditch for convenience in driving over it is very easy, but taking out the sods afterwards is considered too much trouble. Nevertheless, in spite of a number of such stoppages the marshes were in good condition and in the whole distance of fourteen miles not a larva nor an adult mosquito was found.

To restock the ponds with fish, clear the ditches and clean out seaweed in that whole area, $40 was spent, during the early days of May. In the borough of Beach Haven itself, the local board of health maintained conditions in good shape.

JERSEY CITY.

No city in the old mosquito area of the State was freer from mosquitoes during 1909 than Jersey City, and that condition is due to the intelligent energy of Mr. Wm. Delaney, one of the members of the Jersey City Board of Health and the committee in charge of mosquito work.

During the late fall of 1908, one of the contractors cutting hay on the marsh began to do his work without regard to the drainage ditches and, by filling and driving over them at will, promised to change a satisfactory meadow into a bog. When Mr. Delaney's attention was called to the matter he compelled the contractor to make bridges and restore ditches and, later, by the co-operation of the park commissioners who authorized the hay cutting, the ditches were cleaned and mended. Early in March an inspection was made, and a man was found at work cleaning out debris and rubbish that had floated in during the winter. After this work was done, nothing more was needed on the meadow during the summer, and no mosquitoes were bred out on any part of it. Salt marsh mosquitoes in Jersey City were simply non-existent.

An inspection of the Secaucus area, made on March 31st, showed a very satisfactory condition of affairs. A slight blockage of outlets by rubbish, and a little choking of the ditches passing under the pipe line was noted, and that was reported to Mr. Delaney, who had the necessary work done. The Erie railroad had blocked off a small creek, but had substituted a deep ditch in its place, carrying the drainage water into Penhorn creek, and this

had improved rather than impaired conditions. This area also remained free from mosquito breeding all summer.

In the city itself, Mr. Delaney kept two men busy throughout the season. The number of breeding places that were permanently disposed of is very large, and a close supervision was kept over sewer catch basins and breeding places that for any reason could not be permanently abated. Wherever there was complaint of mosquito trouble it was investigated, and usually the source was discovered. On several occasions during the summer Mr. Brehme or myself were in consultation with Mr. Delaney, and Mr. Brehme assisted in locating breeding areas whenever necessary.

The results were all that could be reasonably expected and the Hudson County Board of Health has appointed Mr. Delaney to look after the mosquito work of the county at large, assisting and advising local boards and their officers.

OTHER HUDSON COUNTY AREAS.

There are no typical salt marsh areas in Hudson county other than those at Point-No-Point, Jersey City, Bayonne and Secaucus. But there is considerable marsh land in Harrison, Kearney, Arlington and about Snake Hill.

All of these territories were kept under observation during the season, Mr. Grossbeck and Mr. Brehme taking turns at certain areas, and it seems positive that no breeding of salt marsh species goes on at any point north of the line of the Pennsylvania railroad. There are many points where other species breed, but not so many as is indicated by appearances, and sometimes the species are not of those that enter towns or houses.

At Harrison some bad breeding places for *sylvestris* and *pipiens* developed close to Newark, and these were dealt with by the Newark Board of Health whenever necessary. Much of the exemption from trouble is due to the prolific growth of duckweed, which appears on most of the pools in this section after midsummer. The work of filling and grading that is in constant progress in many of the swampy areas is constantly limiting breeding places and improving conditions.

POINT-NO-POINT.

It was believed and so reported that the work of the Newark Meadows Improvement Company on this area would be carried on to such a point before breeding began in 1909 that there would be little or no danger of considerable flights. But for some reason filling was discontinued on the eastern part of the area, and conditions were left in a worse state than ever before. In consequence, the meadow was a quagmire in texture in early May, with shallow pools of considerable extent, especially along the lines of the old ditches. By the 20th of May a large brood was matured, and the prevailing wind carried them into Newark, where, for a night or two, it seemed as if old-time conditions were to prevail. North of the canal, on Broad street, mosquitoes were present in swarms; south of the canal they were not noticeable. This trouble lasted for three or four days and was then over; it was the only flight of salt marsh species into Newark for the season, its line was clearly marked along the northern shore of the canal, and the species was *cantator*.

Investigations showed that the meadow was rapidly drying up, but that there was another large brood of larvæ in the pools and that prompt action was necessary. I obtained a meeting of representatives of the Newark, Jersey City and Arlington boards of health, with the chief engineer for the Meadows Company, and after some conference on the ground itself it was agreed that the attempt should be made to keep down the insects by oiling—the boards to co-operate in supplying the labor, the Meadows Company to assist in paying for oil and the work to be done under the general supervision of Mr. Brehme and whenever I notified the boards that it was necessary to have it done.

The first application was made in early June, and four barrels of oil were used in three days. The effect was almost perfect and mosquitoes disappeared from the area almost at once. As the water dried, a scum of oil was left on the surface of the ground, and that discouraged oviposition. Thereafter this area was kept under continued observation, and whenever a brood appeared anywhere in the pools after rains or heavy tides, the oiling gangs were put to work, usually requiring one or two barrels applied through knapsack sprayers to cover the area. As the season advanced it

was noted that the broods decreased in size and that after light rains the pools became automatically oil covered, so that the work became ever easier, and two men could do all there was to be done in a single day.

Toward the end of August, while Mr. Brehme was on vacation, a brood of *sollicitans* became full grown before they were noted, and a few changed to adults before the oiling gang was set to work; some of these got into north Newark, but were noticed for a few days only, in very small numbers. Oiling was continued until after the middle of September, and then the meadow was covered with water by the operations of the improvement company, so that no further development of insects was possible.

It was demonstrated that even over a large salt marsh area, mosquito breeding can be prevented by the use of fuel oil, costing eight cents per gallon, by the barrel. Applied through a vermorel nozzle from a knapsack sprayer, a man in rubber boots can cover a large area in a single day, and there is no doubt but that persistent work of this kind through an entire season will very materially lessen the size of the broods for the year following. But it is equally certain that the oil does not kill eggs already on the marsh, and that every time the pools fill up, a brood of larvæ will make its appearance until the entire egg supply is exhausted.

As to the probabilities for 1910, it is impossible to say at present. The operations of the Meadows Company have, during the last two years, completely changed the character of the area. The western half is high and dry, absolutely safe, for good. The eastern half, which was a densely reed and rush covered area, is now partly sand filled, the rushes largely killed out, the old ditches partly filled, so that they are altogether useless for drainage, and there are acres of breeding pools where none were present five years ago.

Of course the filling is going on continually, and it is now proposed to start also from the Hackensack river. Whether the work will be sufficiently advanced to cover over the egg supply now on the meadow, cannot be predicted at the present time. It may be necessary to resort to oil again for another season.

It is interesting to note that while Point-No-Point is really nearer to Jersey City than it is to Newark, it is the latter city that got all the mosquitoes because of the prevailing east-southeasterly

winds. Altogether rather more than $100 were spent by all sources upon this meadow during the season of 1909, but the results were worth it.

NEWARK AND VICINITY.

The Newark problem, as has been indicated in previous reports, is a double one: that of maintaining salt marsh conditions and that of keeping down the house mosquito, which is almost omnipresent. The entire work is in charge of the local board of health, and that has placed it in charge of Commissioner John W. Dobbins, who exercises the authority of the board with an appropriation especially made for this purpose.

During the season, one man was maintained on the marsh almost continuously from early March, and only once was there any breeding on a limited area that was not at once checked. The special character of one section of the marsh, overflowed by sewage, has been brought out in previous reports, and the constant encroachments on the marsh by industrial enterprises make continual vigilance necessary to maintain the drainage scheme.

During the entire season Mr. Brehme has kept general supervision over the marsh, and has notified Mr. Dobbins whenever it was found necessary. The special work of the summer was on the Waverly section, where, by the end of the season, a very satisfactory condition was produced by the man engaged for the work.

The city problem engaged the attention of two men, and that was much more complicated; in fact, it required at times the temporary assistance of the entire force of inspectors when catch-basins needed oiling.

Newark is pre-eminently a manufacturing city and its industries are extremely varied, many of them requiring the use of water in large quantity. At the present time every section is stocked with *C. pipiens,* and in every conceivable place they breed. As an example, attention was drawn to a lot of barrels in the yard of a pickle factory. There were seventy of them, all partially filled with water, and every one with a full supply of wrigglers. These were really permanent breeding places, because water was kept in these barrels to prevent them from going to pieces, and similar conditions were found throughout the city. In the outskirts, at the edge of the meadows, there are factories that drain

their waste water over the open lots adjacent, and create ideal conditions for this house mosquito. Even in cellars in such localities, breeding was found, and the task of the inspectors in locating such places was no light one. Great progress was made, however, in eliminating open breeding places throughout the city and its outskirts, and conditions are becoming better constantly. Some of the higher parts of the city were kept almost free until late in summer, when a sewer basin brood escaped and made matters unpleasant for a time. The organization for such work in the city is not yet quite what it should be, and the commissioner does not get the co-operation of the public to the extent that he deserves.

Some sections of Newark also suffer from the neglect of adjacent municipalities. There are a number of little streams and brooks coming from the highland into the town, and some of these are little more than sluggish open sewers in which mosquito breeding goes on merrily and more or less continuously. Over these conditions the Newark board has no jurisdiction and the other municipalities will not aid.

ESSEX COUNTY CONDITIONS.

It is a pleasure to be able to say that there is at least one county organization that has taken up the matter seriously and successfully. It is difficult, if not impossible, to find at present a mosquito breeding place anywhere in the Essex county parks, and throughout the reservation every danger pool has been drained or filled. The credit for this almost ideal condition of affairs belongs largely to the efficient secretary, Mr. Alonzo B. Church, who has from the beginning shown himself ready to adopt all suggestions made for the improvement of the territories under his charge.

Some of the immediately surrounding municipalities have assisted in the work, and individual owners in and about Short Hills, Millburn and extending into Morris county, have done much to improve conditions. In fact the only serious trouble now comes from *C. pipiens* breeding about the settlements, and largely in cesspools, cisterns, sewer basins and the like.

If the boards of health of Essex county could be induced to cooperate and to employ a good man to locate breeding places and enforce their abatement where they were not voluntarily removed,

a great point would be gained, and the reduction of the *C. pipiens* would be sufficiently great to make its future control much easier.

For almost every municipality in Essex county some work was done during the season, and South Orange still maintains its record for persistently fighting, although since the installation of its sewerage system the problem has materially changed.

LYONS FARMS.

The troubles referred to in the report for 1908 continued to a considerable extent during 1909, and during late summer Mr. Brehme co-operated with Mr. Richards, of Elizabeth, and located a series of breeding areas in a broken stream emptying into the Elizabeth river. It is one of those areas that is not a constant breeder, but is virulent at times, and as it happened none of the previous inspections developed these places. Part of this territory is property of the Lehigh Valley railroad, and this company will co-operate with the other owners in draining the breeding area. Plans for this drainage have been prepared by the county surveyor, and the problem there is now fully understood and in a fair way to settlement.

There is a factory in this town in which were found twenty large barrels partly filled with water, all swarming with wrigglers and supplying the surroundings with a goodly number of biting pests. The breeding places referred to in the last report still exist, and must be kept in mind when cleaning up work begins.

ELIZABETH.

In the report for 1908, it was stated that Mr. Louis J. Richards, the health officer, intended to raise money to widen Great ditch so as to give more ready outlet to the water accumulating west of the Jersey Central railroad. He succeeded in getting rather more than $500 out of the city, and then applied for a similar sum from the State appropriation. The request was granted, and altogether about $1,200 were spent in widening some of the main ditches and improving and deepening Great ditch. The area to be drained, however, is terrific, and in a period of high tides and storms there

is a territory about Great island that cannot be rid of water fast enough to prevent some mosquitoes from maturing. Two such occasions came during the summer of 1909, and some mosquitoes got out each time. Most of them got into North Elizabeth, which, throughout the season, suffered more than any other part of the city; in fact, it was the only part of the city in which mosquitoes were noticeably abundant at any time. Mr. Richards has kept posted on marsh conditions throughout the summer, and has continued to improve them continuously. If the area around Great island could be kept drenched with oil during one season, as we kept down breeding on Point-No-Point, it may be that the egg supply could be exhausted or destroyed, so that this area might be practically safe even during storm periods in summer.

As for the city problem, Mr. Richards has that well in hand, and has continued his warfare against breeding places. One brood only escaped from the sewer basins, and that was not a large one. It was in North Elizabeth that the trouble was worst and some of that came from the breeding places in Lyons Farms, already referred to. There was, however, one other place, located in North Elizabeth, in late summer, on a private ground, from which a large part of the supply complained of had undoubtedly issued. It was completely under cover and disclosed only by accident, but the removal of this pest hole shut off a supply of many thousands per week.

RARITAN RIVER MARSHES.

These have again added to our knowledge during the current year by demonstrating that even in a dry season, combinations may favor the development of a considerable number of mosquitoes. It was reported in 1908 that some breeding was observed on the upper end of the meadow, but it was believed that it would be safe to allow the eggs to breed themselves out. Still closer observations during the season of 1909 made this seem a doubtful proposition and it was finally decided to add 32,000 feet of ditching to the meadow at a cost of $475, this work not being done until after the hay had been cut in early fall, so as to make it possible to determine all the areas from which water did not drain with satisfactory promptness.

It has been already noted that when a combination of high tides with a full river flow was formed, the lower portions of the marshes became flooded and did not readily drain off. This is due in large part to the facts that not only are the meadows clay covered, but they are highest along the river bank. With the high tides and heavy upland supply, the meadows cover from the edge of the highland, and the low banks of the irregular creeks become covered and extend so as to form large ponds. The outflow normally is through the irregular creeks and is very slow, so that every depression may remain covered for two weeks or more, unless there is a run of very low tides.

Our ditches as originally put in provided a number of direct outlets into the river and these have not only maintained themselves, but have improved in character, scouring themselves and in some cases deepening materially at the outlets through the high banks. But they did not provide sufficient outlets for the water between the creeks nearest the highlands, and a few long ditches, shortening the course of the water, were put in, with good effect. Finally it was decided, also, that to avoid the nuisance of occasional small broods that would serve to keep up the egg supply on the meadow, it would be better to drain also those areas that are only exceptionally dangerous.

This has been in many respects the most difficult of all areas to deal with, because conditions varied so much from year to year. The actual amount of local precipitation cuts very little figure, unless it is combined with tidal conditions that prevent the rapid outflow of the water. Nevertheless, there were practically no salt marsh mosquitoes in New Brunswick during the summer of 1909, and very few, indeed, anywhere within the sphere of influence of the Raritan meadows. Mr. Grossbeck, who lives at Highland Park, and not far from the river bank, makes practically the same report. As a serious factor, the salt marsh species from these marshes have been eliminated.

BOROUGH OF MANASQUAN.

Within the limits of this borough there are 240 acres of salt marsh along the shores of the Manasquan river, and this it was estimated would require about 35,000 feet of ditching. Proceed-

ings were begun as usual by the service of notice on the board o health during the early summer of 1908. This board acted upo the notice, and, after the usual communication with the boroug council, served the marsh owners with orders to abate. Failure t do so having given the board jurisdiction under the law, an a signment of $700 was made by the director to do the work, an Mr. Jesse P. Manahan agreed to do it for that sum.

The work was begun during October, 1908, and completed i November, the full amount of ditching being required on th marsh along the river and on the island lying in it.

This was a very bad breeding area, and its position just sout of Sea Girt and the State camp made it a peculiarly annoyin area for a very large number of persons. Machine work was po sible on much of the territory, and the meadow drained perfectly

As the work was done so late in the season and the meadow i a low one, I feared the result of the winter tide and storms, es pecially as these had shifted the mouth of the river, and had a one period almost completely closed it.

March 11th, 1909, when Mr. Brehme investigated the matter he found conditions much better than anticipated, $15 only being necessary to eliminate the blocking that had occurred. The marsh was kept under observation all summer and no mosquito broods developed on it at any time. Camp life, in consequence, was de prived of its greatest drawback, and there were not mosquitoes enough to cause annoyance at any time. But the influence of the work extended much further, and Spring Lake, Belmar and adja cent towns that had theretofore suffered when south winds came, were almost entirely mosquito free during the summer.

WALL TOWNSHIP.

This contains a small area of salt marsh along the Manasquan, covering about 110 acres, and proceedings were begun at the same time as were those in Manasquan borough. It was estimated that 15,000 feet of ditching would be required to make this area safe and Mr. Manahan agreed to do the work for $350, which sum was accordingly assigned by the director. The task was a simple one and no complications developed, so that before the end of Novem ber, this area also was completed.

There was no interference of any kind with this work; it was ; injured by the winter storms, and it remained mosquito-free long as it was held under observation during the summer.

POINT PLEASANT.

This borough is just a little south of the Manasquan river, and ile it has little real salt marsh, there is about 100 acres of swamp ea that is more or less dangerous as a mosquito breeder, and ich we found would require some 17,500 feet of ditching to ke it safe. The work was scattered in small areas and difficult handle, so that its cost, $400, was somewhat disproportionately at. It was all completed in November and maintained itself thout further cost during the summer of 1909. Its effect was ite marked and very little trouble was experienced during the mmer. Some of this was undoubtedly due to *C. pipiens,* but ie *sollicitans* undoubtedly got in on steady south winds from ntoloking and southward, where no drainage work has yet been ie.

BAY HEAD BOROUGH.

This borough has about 128 acres of decaying salt marsh, which ery little above the level of Barnegat bay, and, in some places, eally morass rather than marsh. When the marsh was origi- ly laid down, there was a connection between the head of Barne- bay and the ocean, and a true salt marsh existed. With the ing of that connection, the upper part of the bay was removed r twenty miles from the nearest inlet through which the salt er gets into the bay, while the fresh waters of the Metedeconk er are constantly coming in at this extreme north point. In sequence the water here is scarcely brackish, and there is hardly true tide. A change of from four to six inches between high l low water is usual, and any greater changes are due to heavy ds which may reduce or augment that difference by a foot or re. As the water freshened, the salt marsh began to decay, es- ially at the northwestern corner, and as it decayed it sank un- at present, a difference of one foot in rise will cause the flood- of very large areas. This rotting marsh is extremely difficult

to drain. The mud is so soft that it scarcely holds a ditch, and the differences in level are so slight that securing fall for an outlet was scarcely possible. Only about 13,600 feet of ditches were placed at such points as they could be effectively located, and at a cost of $300. The eastern shore of the bay seems to carry more salt water than the western, the marsh retains its texture much better, and as it holds ditches perfectly, most of our ditches were placed there. Fortunately, the problem here was simplified by the work of the inland waterway commission, which had assigned a contract for dredging the channel from Bay Head to Mantoloking. Some of the owners of the lowlands at Bay Head took advantage of this opportunity to have the material so dredged pumped over their land to raise its level and make a uniform grade. Consultation with the contractor and the engineer in charge of this work resulted in an arrangement whereby all the material pumped from this channel was so placed as to facilitate our work, and, in some cases, so as to lessen our task by filling in areas that would otherwise have to be ditched.

With the completion of this area, the entire salt marsh from the head of Barnegat bay, north to the Hackensack river, is drained so as to practically eliminate salt-marsh mosquito breeding. There are some areas in which additional work will have to be done as our knowledge of the marshes becomes more intimate, but over 90 per cent. of the breeding possibilities have been removed.

DOVER TOWNSHIP.

On the western shore of Barnegat bay, Dover township extends from Kettle creek on the north to Toms River on the south; a direct distance of about five miles, but fully six along the shores of the various indentations and coves. There is a total of 1,744 acres, and it was estimated that it would require 215,000 feet of ditching to drain thoroughly.

Proceedings were begun in midsummer of 1908, and the hearty co-operation of the board of health was secured. Mr. Thomas B. Irons, the president of the board, facilitated matters to the fullest extent in his power, and on the evening of November 5th, called a meeting of marsh owners at his house, which was attended by Mr. Brehme and myself. At that time we secured a full under-

standing with owners, which resulted finally in their adding materially to the drainage system where not absolutely required for our work.

After due advertising according to law, the contract was awarded to Jesse P. Manahan, the lowest bidder, for $6,300, and five machines were set to work at once. By December 19th, the work was completed and the machines were stored at Toms River.

This territory was true salt marsh throughout, but the peat varied in depth from one foot to over three. Fortunately it rested everywhere on a hard sandy bottom, and drainage even in the shallow ditches was perfect, because no hole extended below this sand layer, and everything above it was carried off perfectly.

The difficulties reported for Brick township were, in some respects, duplicated here. There were no places accessible to the work where the men could be lodged, and the contractor was forced to provide a houseboat and to furnish transportation for supplies in order to hold his crews. The bad weather of early winter also caused delays, but on the whole excellent progress was made after the delayed beginning, and everything was completed well within contract time.

Three inspection trips were made through this territory from Bay Head to Toms River, in mid-April, late July and late September, 1909, to determine conditions. In all cases the report was the same. No mosquito breeding anywhere on the meadows, and no mosquitoes in the towns except after two days or more of south or southeast winds.

At Bay Head, the mosquito supply comes from the eastern shore of the bay south of Mantoloking, where I personally found breeding still in progress in early October. At Toms River, any south wind brings supplies from points to the south, and sometimes on east winds across the bay. But it was noticeable and generally observed that until these winds set in, the usual supply was absent and that the number in all cases was far below what was ordinarily expected.

A very interesting feature was the reluctance of the average native to admit that conditions had changed. While newspaper reports and actual experience demonstrated the presence of the marsh mosquitoes in great numbers south of the drained areas, the residents kept on declaring until early September that the time for the flights had not yet arrived. Not until late September

would they admit that a change had occurred, and by that time the improved character of the meadows and their freedom from the usual mosquito pest had forced them to confess the efficiency of the work. In early October there was no difficulty in getting any amount of testimony to its effectiveness.

This marks the southern point of the continuous work and until further appropriations are made the conditions will remain as just reviewed, getting gradually worse if supervision of the work done is abandoned.

STONE HARBOR.

Stone Harbor is on seven-mile beach, at the end of the branch of the West Jersey that runs from Sea Isle City south. It has, during the summer, communication with Anglesea and five-mile beach to the south, and this forms a link in the connection between Atlantic City and Cape May, via trolley, rail and launch. Up to 1908 it has consisted of a small hotel, a shelter that served as a railroad station, and a few cottages. Its location, however, is excellent, the beach is higher than any other in the near vicinity, and its general advantages are such that they attracted the attention of Philadelphia capitalists.

They began operations in 1907, continued them in 1908, laying out lots, grading, filling and leveling streets, and, in the early spring of 1909, they were ready to put these lots upon the market. They were widely advertised, and, in early May, a large number of prospective buyers were carried down on a special excursion. The day was well chosen, the weather was good and everything made for a successful business except one. The time fixed was coincident with the emergence of the second heavy brood of mosquitoes, and those who came to buy returned home, convinced that, while Stone Harbor had many advantages, the mosquitoes were in such numbers as to counterbalance all. The managers' claim that they lost $10,000 in sales on that one day, besides giving the enterprise a reputation that would be difficult to overcome.

After the first shock, the managers wrote me in the matter, and when Mr. Brehme had made a preliminary investigation May 20th, I joined him on May 25th, in going over the territory. The southern end of seven-mile beach was well-known territory to me, and I knew that there were acres of mosquito breeding marsh close

to the life saving station near Hereford inlet, and opposite on the mainland. But after several days we located all the local breeding areas then dangerous or likely to become so. All these places were either drained or oil treated, and a very fair measure of success was attained. The company was ready to expend $1,000, and did in reality expend considerably more in eliminating breeding places within its own control, but the mosquitoes that came in on the west and southwest winds caused considerable trouble throughout the season. This is an example of conditions that are not unusual along the shore, where the local owners or authorities are willing to do all within their power to avoid or lessen trouble, but are simply held up because they have no jurisdiction over the territory where the mosquito pests that lessen the value of their property actually breeds.

So far as Stone Harbor and the area to the south on seven-mile beach is concerned, the breeding places may be considered as under control, but with every west and southwest wind the breeding places on Great sound and Jenkins sound send their swarms over to Stone Harbor, and nothing that can be done there will prevent trouble of this kind. It may come only two or three times during the summer, but that may be enough to kill the resort for the season if the flights come at the right time.

The land company concerned, in this instance, fully recognizes the nature of the problem, and is willing to expend all necessary sums on the territory within its own control; but it is, of course, helpless in the matter of the area along the edge of the mainland or on the islands between the shore strip and the western edge of the sounds.

RED BANK.

During the latter part of June, inquiry came from Red Bank concerning the breeding places for malarial mosquitoes within that municipality. There was a very well defined area of malarial infestation, and the problem was to locate the exact source of trouble. Two ponds were under suspicion and Mr. Brehme was detailed to make the necessary investigations.

This he did June 21st, and his report was that the suspected ponds were quite innocent, but that there existed close to them a

considerable swamp area that furnished ideal breeding places and where *Anopheles* larvæ were actually found.

It was a very narrow valley with a muddy or mossy bottom, with a sluggish stream fed in part by a little brook arising a half mile back, and in part by springs from the hilly sides. The outlet was narrow and the escape was through a large culvert under a road into an ice pond and so on into the Shrewsbury.

I went over the ground myself on July 2d, in consultation with Dr. W. B. Warner and others interested in the problem. Drainage seemed to offer considerable difficulty and, on July 8th, Mr. Brehme was again sent over the ground to investigate the possibility of forming a permanent pond area. He reported that a dam forty feet long, four feet high and four feet broad would raise the level of the water in the gully to such an extent as to drown out the present floating vegetation, would give a clean, well defined bank on all sides, and would not overflow useful land at any point. When stocked with fish such a pond would be entirely safe and would be an improvement to the landscape.

These suggestions were made in a formal report, and I am advised that they have been acted upon and the dam is under consruction.

MISCELLANEOUS.

Numerous inquiries for information were answered for boards of health and improvement associations throughout the State. In Bergen county, especially, there are several municipalities much interested and ready to do active work wherever it can be done to advantage. Information was given in all such cases and sometimes I made or had made such examinations as were needed to guide the authorities. In a few cases lectures were given to inform the general public, and some of these were well attended.

The following resolution was passed unanimously by the N. J. State Sanitary Association at its thirty-fourth annual meeting held at Lakewood, December 4th and 5th, 1908:

"*Resolved*, That the mosquito control and extermination work as now carried on in this State is of the highest possible sanitary and economic importance, and that it should be prosecuted and completed as rapidly as possible."

The State Medical Society acted as follows:

"*Resolved*, That the Medical Society of New Jersey, at its forty-third annual meeting held at Cape May, June 23d, 1909, desires to call the attention of the coming Legislature to the fact that the last Legislature failed to continue the appropriation for the investigation and extermination of mosquitoes conducted under the direction of Professor J. B. Smith, State Entomologist, and request the renewal of the same as provided by a previous act of law, as the Medical Society of New Jersey recognizes the great value to the whole community that has resulted and will accrue from the continuation of this work.

"*Resolved*, That a copy of these resolutions be forwarded by the secretary to each member of the coming Legislature."

NOTES OF THE SEASON.*

A series of observations was made on the habits of *Culex pipiens* at Highland Park on the Raritan river, opposite to and a little south of New Brunswick. Salt marsh mosquitoes were altogether absent after a small flight in early spring, but *pipiens* was bred in many a back yard near by and came to the porches in considerable numbers.

June 25th, four butter tubs with half-inch holes bored into the bottom and partly filled with soil, were sunk in a piece of low ground about twenty-five feet from the house where *pipiens* was plentiful. There was no known breeding place for this insect within a radius of 500 feet from this location, the inspection having been made with great thoroughness to determine this fact. The day after the tubs were put out they filled with ground water through the holes in the bottom, and a slight scum formed on the surface. Nevertheless, on the morning next following this, there were sixty-one egg-boats on the surface and during the evening and night not a mosquito was seen or felt about the house. Apparently the instinct for oviposition was dominant above the desire to feed. During the next few days egg-boats in large numbers were placed in the tubs, and though rarely more than one and usually no mosquitoes were on the porch, two score or more could always be found around the tubs which were set to provide material for experiments

July 7th, all the egg-boats, several hundred in number, were removed in the late afternoon. On the morning of July 8th, there

* These are, as usual, by Mr. Grossbeck.

were 163 new rafts in the four tubs, seventy of them in one tub. Nevertheless, at the house, twenty-five feet away, not a single mosquito had been felt during the evening or night.

Again the boats were removed and next morning, despite the application of a powerful larvicide, forty-two boats were on the water. And so it was from day to day, forty to fifty new boats were laid each night in the four tubs, and sometimes as many as 150, the number apparently depending on the condition of the water. On only one occasion, when a very heavy dose of "Hyco" was applied, did the mosquitoes refuse to oviposit, and that evening it was not only impossible to remain on the porch, but sleep was out of question most of the night.

It would seem then that where natural breeding places are scarce, it is quite possible to attract the mosquitoes for a considerable distance around to an artificial area where they can be kept under observation and control. It seems indicated, also, that when such an attractive place is provided, the insects do not so readily bite or frequent even nearby dwellings. This sort of trapping is quite feasible around any house with a garden, but it means also that the tub or pail must not be forgotten long enough to allow any brood to come to maturity. The larvæ can be killed off every few days with tobacco extract without affecting the water as to attractiveness for oviposition.

Culex restuans has been always recognized as a clean-water mosquito in contradistinction to *C. pipiens,* which, in the first degree, is a foul water species. This difference was well illustrated in the tubs as the season advanced. As already stated these tubs filled from below with ground water that suited *pipiens* excellently well. Later in the season vegetation grew rank about and shaded these tubs, which, accumulating rain water, cleared and left a clean pool. As this change took place, *pipiens* began to decrease in number, and *restuans* appeared in ever-increasing proportions, some larvæ yet remaining on October 23d, although no egg-boats had been noted since September 18th. With the appearance of *restuans,* larvæ of *Anopheles punctipennis* also arrived and were thereafter present in small numbers.

As the season advances, specimens of mosquitoes infested by red mites are not infrequently sent in, and the question has arisen whether these in any way harm the insect that carries them. If they do, the next question is whether any economic use can be

made of them. We have found these mites on perfectly fresh examples, and also on old, worn-out females that had, apparently, disposed of their entire egg supply, and such infested specimens are not infrequently found biting. Mr. Nathan Banks, who knows about these species, says they are aquatic forms infesting larvæ and pupæ, and crawl upon the body of the adult during its emergence from the pupa. The insect is therefore "lousy" from its birth as an adult and yet, nevertheless, seems to live its full span of life.

Culex salinarius larvæ were found on Gillmore's Island on the Barnegat bay shore as late as December 1st, 1908, not yet full grown. This is the latest date recorded for this species so far as I am aware.

Culex aurifer is generally distributed in New Jersey, and usually occurs in large, more or less permanent bodies of water, which are yet shallow and comparatively free from fish. Such areas, often of considerable extent, occur frequently around the edges of the small "lakes" and large "ponds" in Northern New Jersey, and in and around them, adults occur in numbers, often until well on in August. Quite usually their apparent number is greater than is the real, because of their blood-thirsty character, every specimen coming to the attack at once, as soon as their territory is entered.

Larvæ were taken in the Great Piece meadow, April 12th, in some numbers, and it was noted that they occurred only around a particular kind of plant that spread its branching leaves on the surface of the water. The position of the larva in the water is characteristic, the body being nearly parallel to the surface and the head often higher than the base of the breathing tube, so that the body slants backward. The large and conspicuous white antennæ are thrust forward and somewhat downward and, altogether, the larva is an easily recognized one. Reddish individuals of this form, it may be mentioned, are not uncommon.

REPORT

OF THE

ENTOMOLOGICAL DEPARTMENT

OF THE

New Jersey
Agricultural College Experiment Station

New Brunswick, N. J.

BY

JOHN B. SMITH, Sc. D.

For the Year 1910

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REPORT OF THE ENTOMOLOGIST.

Report of the Entomologist.

JOHN B. SMITH, Sc. D.

The winter of 1909-10 was, on the whole, a continuous one. There were few really mild spells, and none of long continuance. Frost set in early and there was frost in the ground and ice on the surface of the water on most days until February. There was more snow on the ground and for a longer period than for several years and the winter moisture was far in excess of that of the two preceding years.

Warm weather set in toward the end of February and moderate temperatures prevailed in March although there was some cold and snow early in the month. High temperatures began after the middle and reached unseasonable heighth during the last ten days. The result was an unusual jump in vegetation, and the trees in the Experiment Orchard on March 28th, were in the condition usually expected about April 10th. In other words, the season at that time was fully two weeks in advance of the normal for that period.

April and May were wet and chilly, but on the whole favored vegetation which grew rank and very soft. Rains continued until June and then came a dry spell which soon became a drought, accompanied by intense heated spells. These conditions prevailed during most of the summer and were not really ended until October. The rank soft early vegetation scalded under the influence of the hot July and August sun and later the ground became so thoroughly dry that trees especially, could not recover and fell easy victims to those insects that are ever on the watch for conditions of this kind.

For hibernating insects the winter conditions were ideal and the mortality among those wintering as adults or in the partly grown condition was unusually low. A few of those that were tempted out by the early warmth of March succumbed to the later wet and chilly spells but, on the whole, it was an insect year, and there was a very large percentage of injury in certain directions.

Some of this will be more particularly referred to later, under appropriate headings.

As noted in the Report of 1909, two lines of work were brought to a practical conclusion. Bulletin No. 225, entitled "Insects injurious to Strawberries" was issued under date of December, 1909, and Bulletin No. 229 entitled "Insects injurious to Sweet Potatoes in New Jersey" was issued under date of February 4, 1910. Both of these proved useful during the current season throughout the State wherever these crops were grown.

The experiment orchard as such, has been discontinued. As the trees increased in size they have decreased in number and are now too large to be covered by that close inspection that was possible in earlier years. The trees will continue to be used as subjects for experiment but there will be no attempt to watch their development or record their performance.

Mr. Dickerson has continued his observations on the root maggots and some very interesting points in the life cycle of the pests have been brought out. The results appear in a later paragraph of this report.

Work with insecticides has been continued in a somewhat incidental way, and altogether in the way of field rather than laboratory tests. By the courtesy of Mr. Howard G. Taylor of Riverton, 10 rows of his apple orchard were placed at our service for a comparative test of miscible oils, and that test is fully recorded herein. Another test, in co-operation with some of the members of the E. B. Voorhees Agricultural Club, was made with Arsenate of Iron and Sulphate of Nicotine. The results of this are given, but are not conclusive. It will require a more rigidly supervised test to determine the usefulness of these materials.

The horticulturist has, during the two or three years last past been carrying on a very important work with peach orchards and has of course found it necessary to use both fungicides and insecticides. The chief injurious insects to be dealt with have been the peach borer and the plum curculio. To supplement and aid the work of Mr. Blake, I have made a series of observations and studies on both of these pests the details of which are herein after given and the results of which will be used in a general bulletin awaiting preparation.

The minor observations and studies are best recorded under the various crop headings and these have been quite numerous despite my almost two months' absence.

Demands upon the entomologist from agricultural and horticultural bodies throughout the State have not decreased, but

very little Institute work has been done during the season of 1909-1910. I have continued also my connection with the scientific and entomological societies of New York, Philadelphia, Newark, etc., and have attended the meetings of the national bodies at Boston during the winter of 1909-10.

The meetings of the Horticultural Inspectors are becoming of ever increasing importance in determining measures of control to prevent the spread of injurious species, and there have been several meetings of the officials of adjacent States, which I have found it desirable to attend.

At the request of Dr. L. O. Howard, Entomologist to the U. S. Department of Agriculture, I appeared before a Congressional Committee to testify in favor of a bill which would give the Department power to regulate the admission of nursery stock under such rules as it might prescribe.

During the year Mr. John A. Grossbeck resigned his position as assistant in the mosquito work to accept a situation in the American Museum of Natural History, New York City, and Mr. Walter S. Abbott, of New Hampshire, has been appointed in his place. Otherwise there has been no change in the staff. The correspondence during the fiscal year closing October 31st amounts to 3,000 pages of letter book or about 4,000 individual communications. Circular letters to nurserymen, &c., are not included in this enumeration.

Both *Gypsy* and *Brown-tail* moths were introduced into the State during the winter of 1909-10, from Massachusetts, and actually hatched before they were discovered in early spring. Fortunately there had not been any dispersion from the nests and egg-masses, and the broods were nipped in time. A large number of plants were destroyed, many others were carefully examined and sprayed, and the entire area was kept under observation during the season. It is believed that the infestation has been completely eliminated; but I have appealed to Dr. L. O. Howard, the Entomologist in charge of the U. S. Government work in New England, for the assignment of a trained scout to inspect the area where the infestation was found.

A small number of nests of the Brown-tail moth were also discovered on nursery stock, and all of these were destroyed in the course of the work. Details of these matters are set out in the report of the State Entomologist, and need not be given at greater length here.

It seemed desirable, however, in view of the number of specimens of insects found in the course of the inspection work to look into the general subject further, and a study of insects oc-

curring or injurious in nurseries has been begun. Already we have found a Tineid Moth in some numbers on Japanese Hemlock, and this has been recently described as a new species by Mr. W. D. Kearfott under the name *Ptochoryctis tsugensis.*

On the same plant and also from Japan we have a scale insect, similar in size and appearance to the San Jose Scale and this also seems to be at present undescribed. It has been kept under close observation during the summer and apparently has not spread.

There is a possibility that the European Red-tail, *Dasychira pudibunda* has obtained a slight foot-hold, and a probability that specimens of that species have been several times introduced on nursery stock during the years recently past. This matter is again referred to in greater detail further on.

The indications are that a greater number of foreign insects than is realized are annually imported into this country, and it is mere good luck, rather than good management that has prevented the establishment of other important exotic pests than those we now have.

It is probable also that occasional beneficial species are brought in, and possible that, with a little help, some of these might establish themselves. I have myself taken a European Coccinellid lid or lady-bird beetle in one of the nurseries, and there may be others of this character.

When it was realized that a great many lots of foreign stock were imported by individuals other than nurserymen, a circular of "caution to importers of foreign nursery stock" was sent out to all the newspapers of the State and to Agricultural Journals generally, with the request that it be published as an item of news. The response was general, and probably three-fourths of all the journals to which the slip was sent, republished it.

So impressed was I with the importance of this danger from foreign stock that I asked the sanction of the Director to a visit to Holland and Belgium to determine the reliability of their inspection service, and to one of the sections of North Germany whence forest trees are introduced in great quantities, to determine the dangers in their practice of introducing diseases and insects injurious to forest plants and especially conifers.

Eight weeks were spent in this investigation which was on the whole satisfactory so far as Holland and Germany are concerned and completely unsatisfactory so far as Belgium is concerned. Details of this part of the work done appears most appropriately in the Report of the State Entomologist.

As usual I have kept in touch with the work being done in New England by both the National and State Governments, and the Director in charge of the work, Mr. Dexter M. Rogers, was good enough to carry me over a large portion of the territory under treatment. I was fortunate, also in having the company of Professor Wm. Morton Wheeler, of Harvard University, on one of these excursions and of getting his assistance in the examination of caterpillars for traces of disease. The outlook is not particularly encouraging. More than a million of dollars are spent, annually, in the fight against the Gypsy and Brown-tail moths and in the cities, towns, villages and well settled areas the insects have been much reduced or practically eliminated. But in the wooded and uncultivated areas matters are as bad or worse than ever. The main roads for several hundred miles are under the care of the National Government and they keep the trees, etc., banded and sprayed for from 100 to 200 feet on each side. It forms a striking example of the effectiveness of the work done when, to the very edge of the spraying, trees are in full foliage, while just beyond the line acres of wood-land and entire hillsides are literally defoliated—only bare sticks remaining.

Practically everywhere diseased caterpillars were found and a very large percentage of the larvæ were, without doubt, destroyed by both bacterial and fungus diseases; but by no means a sufficiently large percentage to be of practical advantage. The practical steps taken will be found, fully set out, in the report of the State Entomologist.

FRUIT INSECTS.

The horticultural interests of the State are steadily growing in value and importance and, in consequence, the insects affecting the various fruits are more frequently the subjects of inquiry than any save those affecting truck crops. In a general way we know the commoner injurious species, their life history and the methods of dealing with them. Yet conditions are constantly changing and we have long since learnt that nature is bound by no iron-clad rules. There is law without doubt, but it is a law that permits adaptation and that works on the whole for the preservation of each species. As no two localities are quite alike in physical and weather conditions, we find that there is a certain latitude in the life cycle of each species that permits its adjustment to its especial surroundings. In consequence the life history of even the best known species occasionally offers us a surprise

when we study it anew under new conditions. So also many of our remedial or preventive measures: we cannot al be sure that the conclusions reached from a series of experir in one section of our country will apply fully elsewhere.

Even our common fruit pests are kept under observa therefore, to a greater or less extent, and within the last ye two Mr. Blake's work in the peach orchards has called esp attention to some of the insects affecting that fruit. Some on the peach borer were given in the Report for 1909: obs tions were continued and some additional experiments were during the season of 1910; some of them in Mr. Blake's orch some in others more readily accessible. The details of thes servations and experiments are given here: the conclusions the practice to be followed in consequence are indicated, and be elaborated in a bulletin that will not contain any det records of the experiments upon which they are based.

The peach-borer and the plum-curculio received the gre attention. Following these the insects troublesome on apple important, while only a few of those infesting other fruits noted.

It is many years since the fruit bark-beetle, *Scolytus rugu* has been as much complained of as during the season just and peach trees have, in general, been the victims. A numb cases were investigated and others were incidentally noted i course of field work. While in almost all instances the i was accused as the cause of the dead or dying trees, it w every case demonstrable that there had been bad practice left the subject weakened and in no condition to resist attac

The insects were undoubtedly favored by the intense heat drought of mid-summer. Many orchards, large and small, were insufficiently fed and yet set heavily, became exha before maturing their crop or, in the case of early varieties, unable to recover from the strain, for lack of moisture. In trees the beetles developing in September found ready vic and the actual injury caused will not become obvious until summer. It was noted that the entering beetles found no culty in establishing their brood galleries, and it is probable the development of the larvæ will show next summer much serious effects than is at present realized by orchardists. No can now be done for the trees already attacked; but their pr removal and the proper stimulation of those yet uninjured limit the injury caused.

The *grape berry moth* was unusually injurious during the season. There is always more or less injury on my own vines, and I usually see a little in the vineyards during the year; but during the past season complaints came from almost every region in the State and the insect, undoubtedly, found the season to its liking.

To test the efficiency of arsenate of lead in controlling the species, I sprayed my own grapes twice, early in the season. Once soon after the fruits set, and again when the fruits were as large as small peas—3/16 inch in diameter or a little less. August 18th, when the fruits were well grown, I asked Mr. Grossbeck to make a careful examination of the crop. He reported 17 berries only that showed signs of the insect attack which, under the circumstances, shows a very satisfactory record for the application.

Rosebugs were decidedly not so much in evidence during the season. Very few complaints were received at the office, and the insects did not attract attention in our field and orchard work. On fruits other than grape they could hardly be said to have been injurious at all, and even in the Vineyard districts they did not seem to have been really injurious except locally and on a very small scale.

The *pear psylla* is almost always a subject of complaint from some locality in the State, but in most places the fruit growers have learnt how to deal with it satisfactorily.

One section was discovered during the winter, where the insect had increased for several years past to such an extent that some farmers, not recognizing the nature of the attack had begun to take out their orchards. A visit to that section during January enabled us to demonstrate the practicability of control, and to point out the adults in their hibernating quarters under the rough bark and deep in the crevices on the trunk and larger branches. Experience has shown that a winter spray of miscible oil, diluted not over 10 times, and applied with force enough to penetrate to the bottom of all crevices, produces satisfactory results. I usually recommend that the rough bark be first removed; but if that is done, it is essential that the spraying be done immediately thereafter, and that the scrapings be either burnt at once or thoroughly drenched with the spray. The insects become active enough to crawl at a very moderate temperature, and if scrapings are left lying during an entire sunny day, they may leave them and get among the soil rubbish for a new shelter. On the other hand the sprayings should not be done at a temperature at or

below the freezing point, as that impairs the efficiency of the oil—unless, indeed, warm water is used in preparing the spray.

Quite unexpected was the recrudescence of the *Pear Midge* in the vicinity of New Brunswick. Very little has been seen of it at the College Farm for some time past, and on my Vermont Beauty pears I saw nothing of it last year. Soon after the pears set on my trees this season I noticed that some of them were malformed, and found the larvæ present at the core. A very few days later Mr. Blake brought in some specimens of Lawrence pears from the College Farm, and these also showed the characteristic form and the blackened core from which the larvæ had already emerged. From Essex and Union Counties specimens were also received, showing that the insect yet retains a foothold in all the localities where it once occurred more abundantly.

A characteristic feature developed on the farm trees. Heretofore every attacked pear that I have ever seen, decayed and fell to the ground. This year some of the Lawrence were so slightly infested that the fruits maintained themselves and came to maturity in a curiously twisted and deformed shape.

Mr. Blake brought in quite a number of these pears in late October, and the accompanying plate figure shows their appearance entire and cut through the center to exhibit the blackened and irregular seed cavity. In these instances the number of midge larvæ was obviously small and only part of the seeds were affected. The remainder sufficed to hold the fruit, but this had lost the power to develop symmetrically and remained a cripple. So far as I am aware this peculiarity has never before been noted.

SCALE INSECTS.

There seems to be little doubt but that the San Jose or pernicious scale is on the decline, so far as destructiveness is concerned. There is still plenty of it here and there throughout the State, and neglected trees and orchards suffer more or less severely; but the original virulence that seemed to carry all before it and to destroy all the infested vegetation has undoubtedly abated somewhat.

The insect still maintains itself, even in well sprayed orchards and takes advantage of every neglect; but it seems to yield more rapidly to treatment. On the other hand, fruit growers are now so universally acquainted with the pest and the best methods of dealing with it, that they never allow the insect to get so firm a hold as in times past.

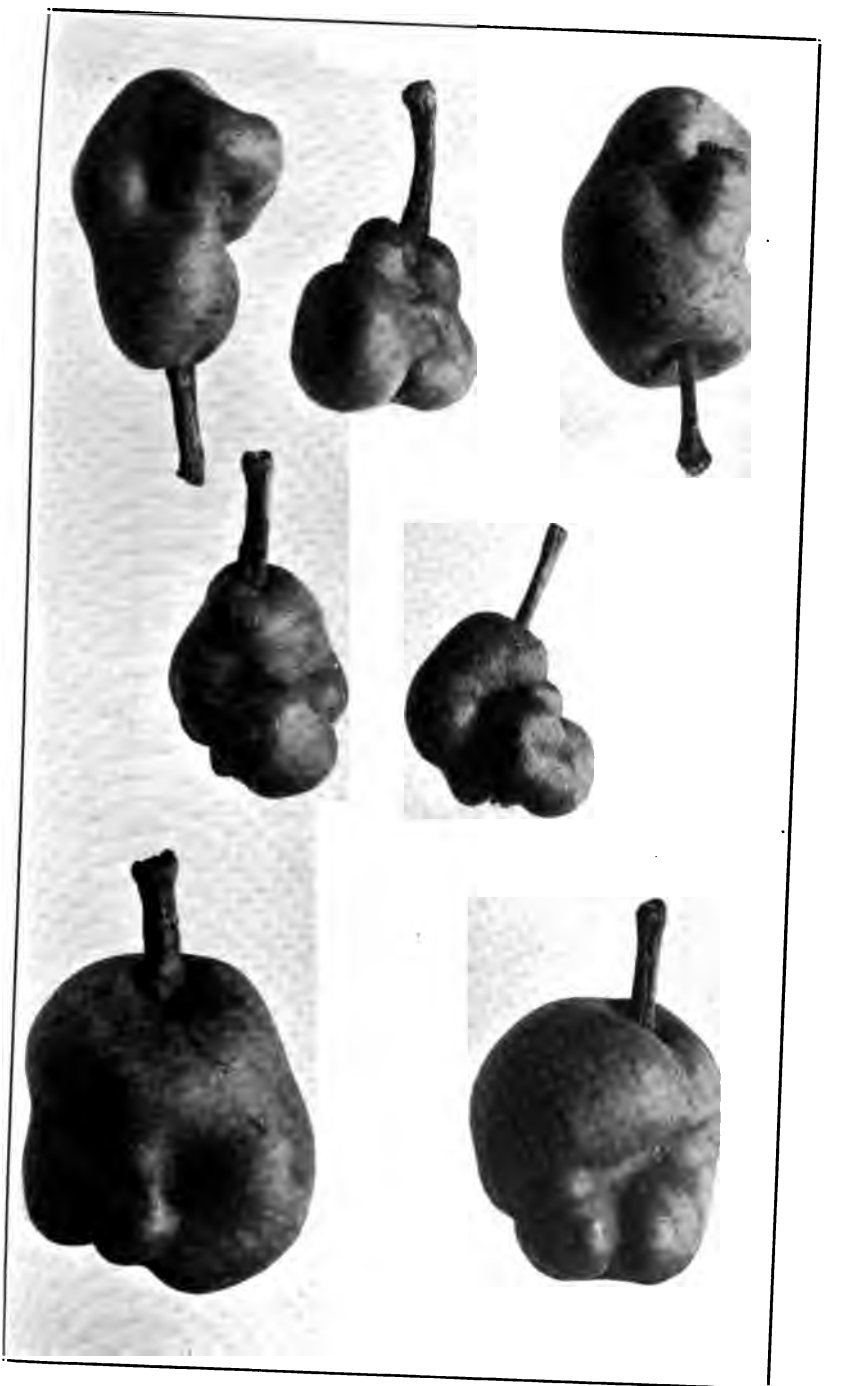


Fig. 1.—Effect of pear-midge attack on Lawrence Pears. Original photograph.

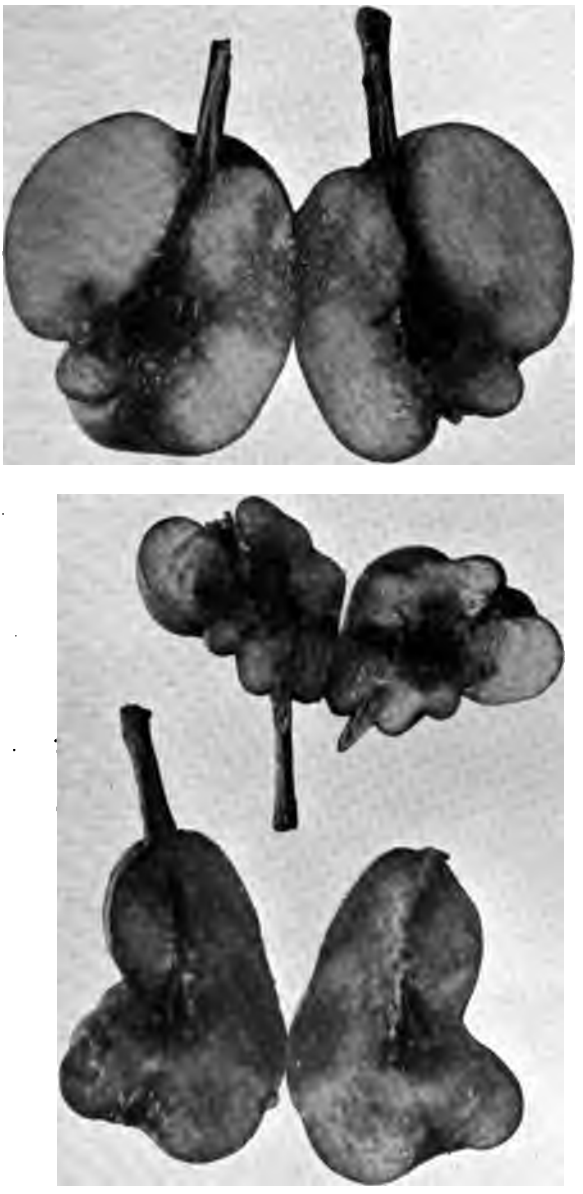


Fig. 2.—Section through distorted Lawrence Pears: effect of Pear-midge injury. Original photograph.

On the College farm orchard which has been carefully treated for several years, Mr. Blake reports more scales this year than for some time past. On my own trees the insect has again increased so as to make treatment desirable; but here no treatment has been made since the fall of 1908 and the infestation is not bad enough to be really threatening even now.

In some localities in Monmouth County where the insect was very destructive a few years ago, growers report very little trouble even where no systematic spraying work is done.

In peach orchards the benefits of lime and sulphur applications have been demonstrated to so marked an extent, that their use is all but universal irrespective of scale, and the consequence is that our peach orchards generally are freer from this pest than almost any others, and cleaner than they have been for many years past. Practically every person that sets out an orchard now-a-days, does so with the expectation of spraying with lime and sulphur, and the consequence is that the scale has no chance.

Furthermore our nurseries are now almost entirely free from this pest. Nearly all the peach nurseries received a clean bill of health at first inspection, and the slight trace of infestation found in others was promptly dealt with as soon as reported.

Pear-growing except of Keiffers, is at present rather on the decline in New Jersey, and the Keiffer is perhaps the most resistant of all the pear varieties, so that comparatively no trouble is found in keeping this crop clean.

Apple growing is decidedly on the increase, and on this the miscible oils have been found best adapted—especially on the older trees. There are still plenty of scale-marked apples to be found; but such crippled fruits as were common a few years ago, have disappeared. There is no sort of doubt that the scale situation in New Jersey is no longer threatening and that the pest is under control. Which is not saying, by any means, that there is no further need to "watch and spray!"

Scurfy scale has been less in evidence than for several years past, and that is an incident to the general treatments for the pernicious scale. Both the caustic and oily winter washes are hard on this insect and kill or scatter a large percentage of the eggs.

Oyster-shell scales are much more hardy and hold their own much better. They were present in normal numbers throughout the State; but there was no unusual outbreak at any point so far as I have been advised.

STRAWBERRY-WEEVIL.

To determine, if possible, exactly where the adult weev spend the winter, I sent Mr. Grossbeck and Mr. Dickerson Egg Harbor on two several occasions in early spring, with i structions to make collections of rubbish in the fields themselv along the edges and at other points in the vicinity. The obj was to ascertain whether or not a winter campaign was possi to reach the adults during a period of dormancy.

The results were not encouraging. Specimens in small nu bers were found in almost all the places tested, but less in t strawberry fields themselves, than in the rubbish around t edges. No one place was found in which specimens occurr in such large numbers as to make it advisable to suggest acti against them. It seems probable that the insects really have choice. They leave the strawberry fields after they mature, b cause they are more disturbed there than elsewhere, and b cause it is too exposed and sunny in mid- and late summer.

For shelter any rubbish covered, moist, protected locality w answer, and nothing seems more attractive than the edge c wood or scrub-land if such is near by.

The distribution of the injury during the season of 191 was irregular, as usual; but it occurred almost everywhere i Cumberland County in some numbers, and did considerable in jury also in some sections of Cape May County. I have nc been advised of any concerted action to discard the cultivatio of the most susceptible varieties.

Other strawberry pests are little complained of. There wa some feeding on the foliage by leaf-beetles and there was little white fly in some sections; but on the whole the crop wa much more seriously affected by climatic conditions than b insects.

THE APPLE LEAF-HOPPER.

Empoasca mali Le B. The apple leaf-hopper occurs through out the State and its work is seen to a greater or less exte each year, chiefly after mid-summer. Up to the summer o 1910, no serious injury had been recorded in New Jersey, an only a somewhat earlier ripening and dropping of foliage i autumn seemed to result. The insect has been under my per sonal observation for several years, and is referred to in almos every one of the Records of the Experiment Orchard. In som

of the States of the middle west and just to the north, the insect is of importance as a nursery pest, and has been made the topic of bulletins in Iowa and Minnesota, besides being referred to in bulletins and reports in several other States.

During the early spring of 1910, it was noted that the insects were present in abnormal numbers, and in May complaints of serious injury were received from several points. One orchard in Middlesex County in particular, showed such an aggravated case of attack, that prompt measures were necessary to avert a total loss of crop. Afterward, in Massachusetts, I saw several apple trees that had been banded with "tanglefoot," where the entire sticky surface was so completely covered by the insects as to appear to be a uniform pea-green. These conditions were by no means uniform throughout the State, but the insect was abnormally abundant everywhere, and as injury may threaten more widely in 1911, it is well to know something of it.

The life history here given is practically based on the records published in Bulletin 112 and later economic publications by Prof. F. L. Washburn of St. Anthony Park, Minnesota, and in Bulletin 111, by Mr. R. L. Webster of Ames, Iowa.

Life Cycle.—The apple leaf-hopper is a very slender pea-green insect, scarcely more than 1/8-inch in length, with a blunt, crescent-shaped head from which it tapers regularly almost to a point posteriorly. It is ornamented with minute white markings which are not easily seen without a lens, hence the insect appears uniformly pea-green. In this stage some of the specimens that mature in September pass the winter, while others lay eggs in minute slits in the more tender bark of the apple twigs and branches. Such of the adults as winter hide under leaves, in crevices of bark, in the stems of grasses or wherever else they can find shelter. In early May the adults come out of their hiding places, feed for a few days and then lay eggs in the leaf petioles of apple, clover and perhaps a variety of other plants. The adults are winged and fly readily, while the long hind legs enable them to jump actively. In fact they usually jump into a flight.

The winter eggs may hatch while the hibernated adults are yet ovipositing, hence the emergence of the young during May is irregular and gradual. The young or nymph that hatches from the egg is very minute, has no wings, but otherwise resembles its parent in shape except that it is a little broader, proportionately, and the hind legs are not fitted for leaping. In fact the insects in this stage and the next move about rather sluggishly and awkwardly. There are five nymphal stages, each in turn

more closely resembling the adult, and 22 days are required fro hatching to the adult form. Adults live two weeks and may li a month under favorable conditions. In Iowa there are fo broods during the season and in New Jersey there are at lea as many and perhaps one more. After midsummer the insects m be found at almost all times on apple leaves in all stages, tho t active adults will, naturally, attract most attention.

Injury Caused.—This leaf-hopper belongs to the same ord as the plant-lice, and like them it gains its food supply by pun turing the plant cells and sucking the juices. Every exhaust cell means a minute spot of dead tissue, and a yellow spot whe the feeding is on the disc of the leaf. All the feeding is, no mally, on the under side and where the ribs or veins of the le are attacked, a hard or dead spot is formed which results, eve tually, in curling or distorting the leaf and checking growt This is most generally found on young trees and forms t chief injury done in the nursery. In the orchard, on bearir trees this distortion is rare: here the leaves will become covered with minute yellow dotlets that the entire foliage o tains a yellowish cast. The tree looks and is sick and the fru does not develop.

This was what happened in New Jersey in June, when t 2nd brood was approaching maturity and the fierce heat ar drought were beginning to tell on the vitality of all vegetab life. This same climatic factor that was so adverse to pla life seemed on the contrary to be as favorable to the hoppe and there was no infant mortality to speak of.

As a matter of interest, it may be noted that the worst i fested orchard seen, is one of the best cared for in the Stat and is regularly and effectively sprayed with insecticides an fungicides as needed. It is also well cultivated and, up to t present season, has had no great numbers of leaf hoppers. T worst infestation was on the outside rows, adjacent to a bit scrub-land, and the insects appeared to work in from that poin

REMEDIAL MEASURES.

There seems to be no particular difficulty in killing the insects in the nymphal stages with soap-suds of modera strength. Prof. Washburn found fish-oil soap 1 pound in 1 gallons of water effective, and Mr. Webster recommends it pound in 8 gallons of water. The only difficulty is—and it is serious one—in hitting the insects with the mixture on lar trees with dense foliage. The adults fly readily and leave t

tree in swarms as soon as the disturbing spray appears, while the nymphs cower closely to the leaf surface and attempt to shelter themselves among the plant hairs or close to the ribs or veins. If the tree is sprayed from the top and from a coarse nozzle under moderate or low pressure, the results will be unsatisfactory from all points of view. If the pressure is high and a moderately fine, forcible spray is sent in from *below* and from the sides, the adults will be caught in flight and the nymphs will be reached in large quantities in their shelters. The results in this case depend not so much on the material used as upon the method of using it—which is true of a great many other spraying operations as well. Laundry soap seems to act as well, at slightly greater strength, as the fish-oil soap; but no arsenical or other stomach poisons are in the least effective.

Whale oil soap was used in New Jersey at the rate of 1 pound in 6 gallons of water, with good effect.

CODLING MOTHS.

These insects still exact toll from the apple grower that does not spray and to some extent even from him that does. For a great variety of reasons which need not be enumerated here, no spraying against the first brood is ever entirely successful. On the early varieties so few apples are injured that they scarcely count. On the later varieties, in the more southern parts of the State, there is considerable second brood injury at the sides of the fruit. The actual percentage is not really large, but every apple injured at that point is really unmarketable—which is not always the case with those attacked by the first brood.

Few growers spray for this second brood and those that do, have not found results sufficient to encourage them to continue. I have recommended banding as against this brood, and to see just what these bands did, I had a number of them removed from the trees of a Gloucester County orchard, January 5th, 1910. It was easy to determine at once, from the condition of the bands, what sort of crop had been borne the year before; the number of larvæ agreeing excellently with the reported size of the crop.

The bands were of doubled burlap and about 4-6 inches wide. Some of the larvæ were between the band and bark, spun up in rather tough cocoons, others were spun up in the same way between the burlap layers.

Four of the worst bands were selected and the larvæ counted to determine their location.

	No. 1	No. 2	No. 3	No. 4
Spun between band and tree	55	73	64	71
Spun between burlap layers	14	41	26	10
Total	69	114	90	81

The inner layer, between the burlap and bark is therefore decidedly favored by the larvæ, and the number of specimens is quite sufficient to make it worth while to collect and kill them. The trees, it should be said are large, vigorous, in full bearing and crop several barrels per tree. Quite a number of other insects and spiders were found under these bands, most of them beneficial (lady-bird beetles), the remainder harmless.

The larvæ of Codling moth were all in good condition, plump and healthy. A few examples were selected as specimens, the remainder were laid away in a cool, dry place until spring.

April 28th, it appeared that the place while cool enough to prevent development, had been too dry for the insects, and only those in the complete and thickest cocoons, remained in good condition. None had yet changed to the pupal stage. The cage containing the bands was then brought up into the normal outdoor temperature and adults began to emerge May 24th. No parasites were bred out of this lot.

On the whole, I consider the banding in South Jersey orchards, particularly on older trees with close thick heads, a decidedly useful process.

OTHER APPLE INSECTS.

Early in the season there was some complaint of *plant-louse* injury in some localities; but this was not wide-spread, nor did it last throughout the season. In midsummer some injury could be noted on certain varieties in most orchards; but the insects themselves had disappeared. No spraying was done against these pests so far as I know.

The *yellow-necked caterpillar* was abundant enough to be troublesome, in a few localities only. It requires a tolerably bad infestation of this species, however, to bring out complaints, so that its numbers were somewhat abnormal.

A somewhat unusual infestation for New Jersey was an attack of the *green apple-worm,* the larva of a species of *Xylina* or owlet moth, which is occasionally troublesome in New York State but has not, heretofore, appeared in our orchards. Not much injury was done and no remedial measures were adopted.

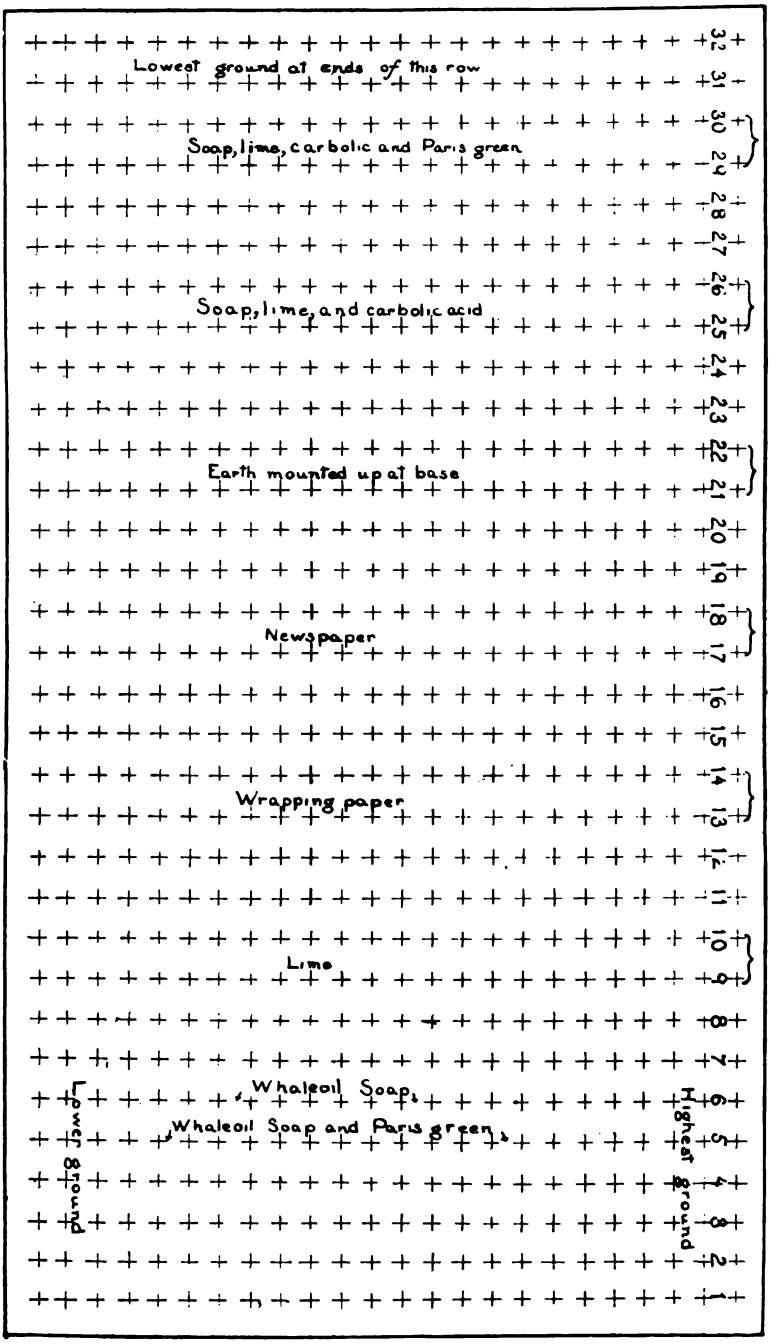


Fig. 3.—Diagram of Peach Orchard at Mercerville, showing arrangement of experiments.

PEACH BORER NOTES AND EXPERIMENTS.

A series of experiments was made in an orchard at Mercerville which originally contained 768 trees in 24 rows 32 trees long. This orchard was carefully examined by Mr. Dickerson June 18th, and found to be infested with borers throughout. The larvæ varied in number and were in varying stages of development; but only 3 cocoons were found. The orchard as a whole was in bad condition, quite a number of trees had been already killed by the borers, others were dying from the same cause. It was an ideal place for a severe test of materials. The plan was to run across varieties of which there were a number, so that the rows numbered from 1 to 32, would take in every variety in the orchard. It appeared later, however, that the information was misunderstood and that the experiments really ran with the varieties, and that the arrangement was as follows:

KEY TO THE MERCERVILLE PEACH ORCHARD.

Rows.
1—2 Fox's Seedling.
3—7 Beers Late.
8—9 Stump.
10—13 Old Mixon
14—17 Reeves Favorite.
18—22 Mountain Rose.
23—24 Waddell.
25—30 Miss Lolo.
31—32 Greensboro.

June 23rd and 24th Mr. Dickerson, aided by Mr. H. F. Smith, made the following applications:

Rows 1-4, inclusive, were left untreated.

Row 5, treated with whale oil soap and Paris green, made up at the rate of 1 pound of soap in 1 gallon of water, and Paris green added at the rate of 4 ounces to 3 gallons. The mixture was too thick to spray and was liberally applied to the trunks with a brush. At this time no soil was removed from the trees at base, and the material was allowed to run down the trunk and soak into the soil at the base.

Row 6, treated with whale oil soap made as before, save that the Paris green was omitted.

Rows 7 and 8, were left untreated.

Rows 9 *and* 10, treated with a shovel full of dry slaked lime. The fresh lime had water enough thrown upon it in the morning to start slaking, and it was used in the afternoon when it had crumbled to a powder.

Rows 11 *and* 12, were left untreated.

Rows 13 *and* 14, were wrapped with heavy, smooth p paper. The dirt was hoed away from the base of eac and the paper, 15 inches wide, was wrapped twice aroun tree, tied with a soft cord at top and then the soil was re so as to hold the paper firmly and cover it for 3-4 inc bottom.

Rows 15 *and* 16, were left untreated.

Rows 17 *and* 18, were wrapped with newspaper in the way as with the wrapping paper on rows 13 and 14. In al papered rows the masses of gum and dirt adhering to the were scraped away; and some borers were cut out; but no was made to remove all of the borers.

Rows 19 *and* 20, were left untreated.

Rows 21 *and* 22, had the earth mounded up about the at base, about 10 inches. No larvæ were removed and, there was no effort to do "worming" at all.

Rows 23 *and* 24, were left untreated.

Rows 25 *and* 26, treated with whale oil soap, lime an bolic acid, prepared as follows:—The soap was dissol pound in one gallon of water, slaked lime was added to n thick cream, and to every bucket ½ pint of crude carbol was added. It was all thoroughly mixed and applied trunks with a brush, from the base to the branches.

Rows 27 *and* 28, were left untreated.

Rows 29 *and* 30, were treated like 25 and 26, save t each bucket of mixture 2 ounces of Paris green were add

I did not consider the applications on rows 5 and 6 satisfa so on June 29th Mr. Dickerson hoed away the soil from th of each tree and carried the application about 6 inches the surface, afterward replacing the soil. A tobacco oil soap was used on this occasion, the previous supply bei hausted. The Paris green in the Row 5 mixture was u the rate of 2 ounces in each gallon.

There was some rain after the applications and as the c period approached, I sent Messrs. Dickerson and Grossb July 8th, to renew the more readily soluble materials.

Row 5, the application was duplicated, using 1 ounce of green in each gallon of mixture.

Row 6, the application was duplicated. In both the ro soil was first removed from about the base and after the cation it was restored.

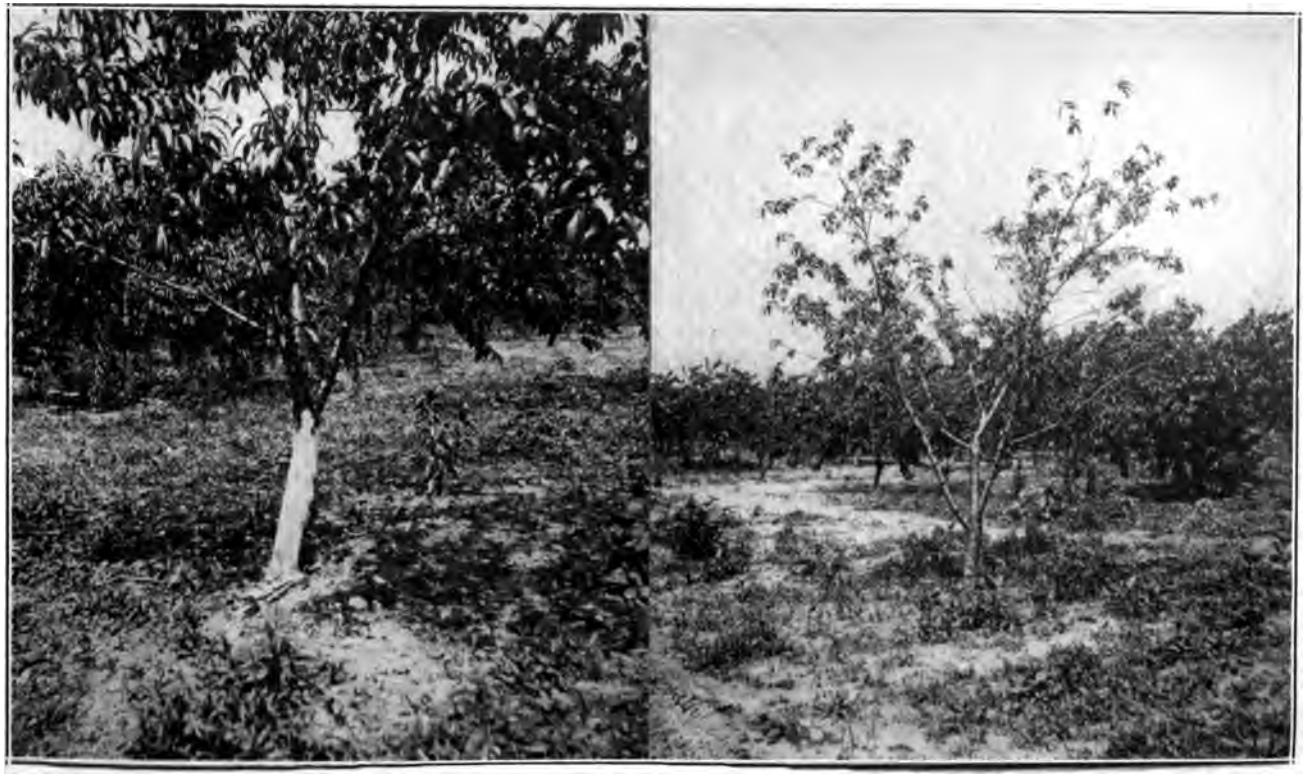


Fig. 4.—At the right, peach tree dying from borer attack. At the left, tree treated with lime, soap, carbolic acid and Paris Green. Original photo.

Fig. 5.—Peach trees in Mercerville Orchard; at *right wrapped with newspaper; at left with smooth stout wrapping* paper. *Original photograph.*

Rows 25, 26, 29 and 30 had the covering still in fairly good
.pe; but beginning to scale off. It was therefore duplicated
m some of the original material that had remained over.
On this date 15 cocoons were collected and it was noted that
larvæ were maturing rapidly.
To fix the date of emergence as nearly as possible, Mr. H. F.
ith was sent July 13th, and brought in 47 apparently good
oons and 15 with empty shells from which adults had already
:rged. As no empty cases were seen July 8th, emergence
an some time between July 8th and 12th. Parasites issued
July 14th and 15th, as it afterward proved from 1 cocoon
r, and up to July 29th, 24 adults had emerged. At that date
Grossbeck examined the remaining cocoons and found 5
d with sand and probably from the previous year; 5 contained
d larvæ; 9 sound pupæ; 16 contained pupæ that were hard
dry; 3 were dead yet flexible; 2 contained mouldy pupæ and
ontained a pupa from which the parasites had been ob-
.ed:—thus accounting for all the collected cases. It should
;aid that when this collection was made there were yet many
·e larvæ than cocoons and pupation had scarcely more than
un, even tho some adults were already on the wing.
August 5th, an examination of the trees showed the mixtures
rows 5 and 6 still evident, but decidedly thinned out. On
's 25, 26, 29, 30, the application was conspicuously present
the lime showed a tendency to scale or flake off. Yet the
ering remained fairly good.
The lime about the trees in rows 9 and 10 had become more
less caked, sometimes in a solid ring, sometimes in segments,
l in most cases still hugged the trunk closely. A few of the
es were examined without finding evidence that any borers had
n killed by the lime, while in one case a larva was actually
ming its cocoon beneath a small cake of lime.
The wrapping paper on rows 13 and 14 showed a tendency to
ome soft and ruptured at the surface of the ground. This
aking seemed to be caused, in part, by the emergence of the
lts. Seven trees were noted in this condition, and in one
e where the break was large, a young borer was found in the
k just above the surface of the ground. The soil was hilled
around these exposed places so as to protect them and on
ee other trees the wrappings were retied in better shape.
On rows 17 and 18, the newspaper wrappings were in much
ter condition. On only six trees were the wrappers at all
oken and then not badly, evidently by the emergence of the
lts. A few others had been intentionally torn away by
F. Smith in searching for cocoons. All breaks were re-

paired by re-tying or mounding. There was no appearanc feeding by young larvæ either above or below the bands. many cases larvæ had perforated the paper wrappings to exit to the adults and in one case 9 holes were found in a n paper section 5 inches long and 2 inches wide. Quite a nur of pupæ were found between paper and bark and it is evi that this kind of wrapping forms no barrier to the emergenc adults.

Only 2 very young larvæ were seen, and a few others ra from ½ to 2/3 growth. Some also were apparently full-gr tho not yet ready to pupate. Thirteen sound cocoons were lected, but most of those seen had empty pupal shells only.

The trees that had been mounded remained as left and not in any way disturbed.

August 24th, the soap washes were reduced to slight tr The washes containing lime were still conspicuous, but scaled off considerably, leaving the coatings incomplete. paper-wrapped trees remained in good condition and showe further tearing. The mounded trees and those with the about the base remained as previously noted.

No systematic collections were made, but young larvæ noted on several trees and there were still some sound coc The conclusion was that the bulk of the brood had change adults and that only stragglers remained.

September 16th, Mr. Dickerson noted that the applicat were yet in as good condition as might be expected. The washes showed very little, while on the rows where the washes were used the trees varied. On some the coating yet comparatively complete, on others it had scaled off al entirely. The average was good. The mounded and li trees were as in previous examinations.

Both wrapping and newspaper remained for the most pa good condition; but in some instances it was broken just a below the surface: doubtless due to the softening by the exu gum and the working of the borers. In this point the newsp was better than the wrapping paper. None of the treated t were disturbed. On the check trees no full grown larvæ no cocoons were found. Apparently the season for the b was over.

The orchard was now in distinctly bad condition. It had very heavily, there had been no thinning and branches had br in every direction. The fruit had been gathered in the roug possible way and branches had been broken down as the ea way to get fruit otherwise out of reach from the ground.

Fig. 6.—Peach orchard at Mercerville in late October. Result of borers, neglect, overbearing and bad picking. Original photograph.

From October 24th to the 28th, Mr. W. S. Abbott examined the trees in the orchard, with the following result:—

One full row of untreated trees was carefully examined. Two trees were dead, apparently from borer attack and, in this connection it should be said that there was scarcely a complete row in the orchard. Two trees were free from borers; three had from 15 to 20 each and the remainder ran from 6 to 8 per tree. They were on the average from 3 to 6 inches below the surface and ranged in size from the very small, second stage, to the full-grown borer.

Row 5, treated with whale oil soap and Paris green: trees nearly all dead, due to a combination of borer, fruit bark beetle, neglect and insecticide. There is no doubt that the caustic in the soap rendered a large percentage of the arsenic in the Paris green soluble and that this hastened the death of the trees. The openings made by the borers gave free entrance to the arsenious acid and the characteristic black discoloration of the sap wood showed the results.

Row 6, treated with whale oil soap only. Only a trace of the application remained. One tree out. Only six of the 23 trees contained any larvæ and there were only 12 larvæ on the six trees. All the trees are in fair condition but some gum and old borings. Certainly a remarkable showing.

Row 9, treated with a shovel of dry slaked lime to each tree. The lime had formed a hard cake around the base of the trees but was often cracked, and generally a space was left between it and the trunk. Six trees were dead or missing. Of the remainder 8 were free from borers and 10 contained an average of 4 larvæ each.

Row 13, treated with wrapping paper. Paper generally in good condition, twine broken in three cases but papers entire. Two trees out. Four trees were free from larvæ and 18 trees contained an average of 3½ each. The bark beneath the paper was in fair condition but there was some little accumulation of gum or "jelly."

Row 17, treated with newspapers. Paper generally in good condition, string broken in six cases. Papers more or less chewed in several instances and termites were found beneath them in 5 cases. Bark as a rule in rather poor condition with much gum or "jelly." Three trees were missing, 2 were free from borers and 17 gave an average of almost 5 each.

Row 21, earth mounded up around the trees. Trees in fair condition, bark generally firm, not much gum or jelly. One tree was missing, 11 were free from larvæ and in 12 there were

17 altogether—an average of about 1 2/5 per tree. All these larvæ were found quite deeply, below the surface level, and much below the top of mound.

Row 25, treated with whale oil soap, lime and carbolic acid. The mixture still showed very plainly. Bark as a rule soft, with plenty of gum or jelly, larvæ deep, often 12 inches below the surface. Three trees were missing, 2 were free from borers and 19 had an average of 5 borers each.

Row 29, treated as before, with Paris green added. Trees in fair condition, with little gum or jelly. Four trees out, 15 trees free from borers, 4 trees with a total of 7 larvæ, or almost 2 each.

SUMMARY.

Treatment.	Trees Out.	Infested.	Free.	Borers Per Tree
No treatment	2	20	2	7
Whale oil soap and paris green	all trees dead.			
Whale oil soap	1	6	17	2
Lime dry-slaked	6	10	8	4
Wrapping paper	2	18	4	3
Newspaper	4	17	2	5
Mounded	1	12	11	2
Whale oil soap, lime and carbolic acid	3	19	2	5
Same, with paris green	4	4	15	2

The results were altogether unexpected and inexplicable to me.

To clear up some of these matters, if possible, I sent Mr. Abbott into the field again, November 7th. Examination of untreated trees in other parts of the orchard gave the same average of infestation as before—i. e., 7 larvæ per tree.

The second row of newspapered trees also confirmed the previous conclusions, as did those wrapped with package paper.

One marked peculiarity of the November collections was the very large proportion of borers in the last or full-grown stage. Literally every stage from the second to the last was represented, and raises the question whether some of the specimens that do not get beyond the second stage really mature during the year following.

The observations have opened up a line of work that will require at least another season to bring it to a satisfactory conclusion.

VINELAND OBSERVATIONS.

The careful work done at Vineland by Mr. Blake during the eason of 1909 demonstrated its value in 1910, when during the pring examination very few borers were found.

The following applications were made during the summer. une 7th and July 8th, all trees save those in every 6th row unning east and west—the dividing rows separating the various locks—had the trunks sprayed thoroughly from the surface f the ground up.

June 7th, 20 pounds of lime were added to 5 gallons of home-ade concentrate of lime and sulphur, and that was reduced to 5 gallons.

July 8th, 40 pounds of lime and 4 pounds of Good's rosin sh-oil soap were added to 2 gallons of commercial concentrate Rex or Grasselli) and reduced to 50 gallons. One hundred allons were used at the second spraying to cover the trunks of 75 three-year old and 534 two-year old trees.

November 11, 1910, Mr. Dickerson examined for results as llows: two or three were examined in a sprayed row, next an untreated row, and then the corresponding trees in the tter row were looked at. In this way both sprayed and un-rayed trees in relatively the same position in the orchard were amined.

First examined several rows at the eastern end, next to a eighbor who does not "worm" his trees. In most cases here e treated trees showed up better than those untreated, being ss infested and, in some cases decidedly so. In one instance wever the treated trees were just as badly if not worse in-sted than those untreated.

In like manner, trees examined through the center of the rchard showed better on the treated than the untreated trees: ere were fewer borers and less injury.

In the younger orchard part of the treated trees showed less nfestation than the untreated. But at the ends of two rows here was little difference between treated and untreated trees in the amount of borer infestation.

Taken as a whole the treated trees are less infested than those untreated, and indicate that a continuation of the work is desirable, with perhaps an additional later application, or a later application in place of the first.

Most of the larvæ observed were small or very small, only one or two as much as half developed and no larvæ as far along in growth as those secured at Mercerville.

An interesting feature was the depth at which the larvæ, even when very small, were found. One of the smallest was in a tree taken up by Mr. Blake as diseased, and that was fully a foot below the surface. Others equally small ranged anywhere between that depth and an inch or less below the surface. These young larvæ often go deeply down without leaving any evidence of their work and without really feeding at all. In other cases they seem to begin feeding soon after emergence as indicated by the saw-dust. In several instances, where very small larvæ were found resting on the outer surface of the bark, they were entirely protected by a covering of minute particles gummed together.

The remarkable disparity in size between the larvæ from Vineland and Mercerville led me to send Mr. Dickerson down again, with instructions to search older, untreated trees, beyond the influence of the systematic worming in Mr. Blake's orchards.

The work was done November 23rd, and on a series of badly infested old trees exactly the same conditions were found that Mr. Abbott reported from Mercerville: larvæ from the 2nd to the final stages in great numbers.

It goes without saying that these observations simply open the way for a new series of carefully planned experiments for another season.

CURCULIO OBSERVATIONS.

The question as to the amount of injury caused in New Jersey by the plum curculio was touched upon in previous reports, and my general belief expressed that as a matter of fact the actual injury in a normal season in a bearing orchard was negligable. It was realized that in a season of small set and scant crop the percentage might be serious, and that on young trees bearing the first crop, the percentage of injured fruit might be serious; but as a general statement my observations in the orchard had led me to believe that no real injury was caused, that the trees in general bore more than they should for their own best interests, and that the drops were not generally due to curculio injury at any rate. Some figures were given to bear out this belief, but no systematic observations were made.

Mr. Blake's convictions in the matter did not agree with my own. He was inclined to look upon the curculio injury as a serious matter, especially because it reduced the commercial value of the fruits that, altho punctured, remained on the tree

ripen. That feature of the case had not been considered in y estimate, and as Mr. Blake had in hand a series of spraying periments on his orchards at Vineland and High Bridge, I ranged with him that he should send in for examination all e dropped fruit from selected trees and should, when harvest-g, count and report upon the condition of the crop.

During the season Mr. Dickerson visited the Vineland Or-ard on several occasions and I consulted frequently with Mr. ake as well as Mr. Dickerson as to conditions and develop-ents. All the counts were made by Messrs. Dickerson and ossbeck, while the summaries and collation of notes were epared by myself.

Supplementing the systematic observations in the experiment chard, all of us studied conditions in commercial peach or-ards throughout the State, including for myself some of the st in Burlington and Gloucester Counties, where quality and uantity of crop receive at least equal consideration.

There are certain factors that must be considered in any timate of results and in conclusions reached. The set of fruit, pecially in the Carmans, was abnormally heavy, and after all ops from all causes, most trees over-bore and some orchards esented a pitiful sight at ripening period, branches breaking such an extent that many trees were absolutely ruined. Many uits simply could not reach proper size and made seconds or en culls for this reason alone. On such trees, no matter how any of the fruits had dropped because of curculio injury, com-ercial injury could not be claimed, because the crop would have ought more had the drop been much heavier.

Of course this takes no account of injury to commercial value ie to defacement of ripened fruit; but, as a matter of fact there as very little of that. In the Stanger Orchard near Glassboro went through just after the picking of Carmans had well gun, and a curculio marked fruit was a rare exception on any e. In the packing shed a very large percentage went into the ncy quality baskets, most of the remainder ranked No. 1, while e culls were few in number and of even these not many showed rculio injury.

In one point all observations agree: the early varieties are all ich more liable to curculio attack than any late varieties and e latest varieties are practically exempt from injury. This not due to any difference in date of blooming or setting, nor to y difference in rate of early growth: it is simply a fact, as yet thout satisfactory explanation.

On another point Mr. Blake's observations are peculiarly decisive, because of his close attention to surroundings. Curculio injury is much worse on the outer rows adjoining wood or scrub-land, and lessens, even on the same varieties, toward the center of the orchard. The importance of this fact is realized when we consider how easy it would be to make a false showing for any treatment by leaving such an outer row as a check, while selecting an inner one for the test material. Conversely, a really good material applied to an outer row, might make a very poor showing as against a centre check row.

While the results of the counts made and of the observations this year do not show, in my opinion, a very heavy commercial loss due to plum curculio, they do show the fact that a very large number of fruits are actually used for feeding and for oviposition and that a very large number of curculio larvæ actually develop each year.

For instance in the check Carman lot, there were 197 larvæ by actual count, the majority of which, under ordinary orchard conditions would have matured. Using this as a sample of what occurs in an unsprayed orchard, the number of beetles developing reaches a high figure. While many of these succumb to the dangers incident to hibernation, even a small percentage of survivals would play havoc with a small set, especially on outer rows adjacent to winter hiding places for the adults.

In the examination of the drops, it was intended to bring out any relation that there might be between curculio punctures and beginnings of rot; but it is questionable if that has been done. It was brought out, definitely enough, that many of the curculio marked fruits were entirely without trace of rot; but it is not brought out in how many cases, where rot and curculio injury co-existed, the rot started from the curculio injury. In some cases that could have been determined; but in so many others so large an area of rot existed, that its starting point could not be definitely determined. It was, however, determined that in a very fair percentage of cases rot existed without trace of Curculio injury. The most that can be said is that a curculio puncture does not of necessity result in a rotten peach; nor on the other hand, does the disease need a curculio puncture as a point of entrance.

Finally, before letting the record speak for itself, it should be noted that the peaches recorded as sound, were mostly drops due to defective pollination, or, in the case of larger, later drops, due to mechanical dislodgement on overcrowded, interfering twigs.

From field notes made, it appears that the curculio begins to ed during the first days of May, and oviposition begins in uth Jersey about the 10th. Egg punctures were found on aches at Vineland May 12th, and at Glassboro on pear, apple d peach, May 14th. Egg punctures on peach were at these tes very difficult to discover because of the very long pile on e young fruits. Mr. Dickerson, who made the Glassboro cords, notes that infestation was much worse near neglected nces, etc. This of course means that the beetles went no rther than necessary from their hibernating quarters to feed, d that oviposition began very soon thereafter without much velling.

For dates of spraying and materials used Mr. Blake's report another page of this volume should be consulted.

CARMAN NO. I.

Check tree—not sprayed.

y 28—Total drops			83
ne 2— " "			296
4— " "			186
9— " "			101
23— " "			25
			691
y 28—Sound fruit		2	
ne 2— " "		3	
4— " "		58	
9— " "		17	
23— " "		7	87
Defective from rot or Curculio			604
y 28—More or less rot		33	
ne 2— " " " "		234	
4— " " " "		90	
9— " " " "		84	
23— " " " "		14	455
Curculio marked, without rot			149
Total defectives			604

May 28—Curculio injury of some kind			74
June 2— " " " " "			257
" 4— " " " " "			128
" 9— " " " " "			54
" 23— " " " " "			18
Rot without Curculio			
Curculio injury of some kind			
May 28—With larval galleries			74
Larvæ present	74		
June 2—With larval galleries			168
Larvæ present	79		
" 4—With larval galleries			38
Larvæ present	30		
" 9—With larval galleries			18
Larvæ present	10		
" 23—With larval galleries			10
Larvæ present	4		
	197	308	
Feeding or egg punctures only			
Very slight galleries without larvæ		111	

Feeding punctures were specifically recorded on 93 of the drops.

The galleries without larvæ were not sufficient, in most cases, to cause dropping.

This record should be compared with that of Carman No. 3, which contains in comparison a remarkably small amount of curculio injury and about as much rot.

When the fruit was picked the following record was made by Mr. Blake.

With Curculio larvæ	3
Appearance considerably injured	48
Marked but not commercially injured	106
Perfect fruits	377
Total number of picked fruits	534
Total number of dropped fruits	691
Total number of sets	1225

This means that 56.4% of the entire original set dropped, 43.6% reached full size and that a little more than 30.7% of the original set made perfect fruit at ripening.

The number of curculio marked fruits reached 688 or over 56% of the whole set, and of those that reached full growth over 31% were marked by the insect, although less than 10% were commercially injured.

CARMAN* NO. 2, SPRAYED WITH ATOMIC SULPHUR.

June 2—Total drops			33
" 4— " "			21
" 9— " "			12
" 23— " "			31
			97
June 2—Sound fruit		2	
" 4— " "		1	
" 9— " "		1	
" 23— " "		16	19
Defective—rot or Curculio			78
June 2—More or less rot		11	
" 4— " " " "		2	
" 9— " " " "		0	
" 23— " " " "		6	
Total fruit with rot		19	
			19
Defective and with curculio but no rot.			59
June 2—Curculio injury of some kind		30	
" 4— " " " " "		20	
" 9— " " " " "		11	
" 23— " " " " "		14	
		75	75
Rot but no curculio			3
Curculio injury of some kind			75
2—With larval galleries		30	
Larvæ present	8		
4—With larval galleries		20	
Larvæ present	17		
9—With larval galleries		11	
Larvæ present	10		
23—With larval galleries		10	
Larvæ present	3		
	38	71	71
		38	
Galleries without larvæ		33	
Feeding or egg punctures only			4

Feeding punctures were noted on 15 examples.

All the galleries in this fruit were well marked and might have caused the dropping; but the percentage of rot is small.

When the fruit was picked, the following record was made by Mr. Blake.

*Not true to name; is really Snow's Orange.

With curculio larvæ	00
Appearance considerably injured	30
Marked but not commercially injured	114
Perfect fruits	248
Total number of picked fruits	392
Total number of dropped fruits	97
Total number of sets	489

This means that not quite 20% of the original set d and that a little over 50% of the sets made perfect fruit at ing. This seems a great gain over the 30.7% of the but the varieties are not the same and the set was nowhere so great.

44.7% of the entire set was Curculio marked, and 5 those that reached full size were so injured; but here al than 10% of the fruit that reached full size was comm injured.

CARMAN NO. 3.

Sprayed with Atomic Sulphur.

May 28—Total drops		
June 2— " "		
" 4— " "		
" 9— " "		
" 23— " "		
May 28—Sound fruit		5
June 2— " "		26
" 4— " "		46
" 9— " "		11
" 23— " "		15
Defective from rot or curculio		
May 28—More or less rot		23
June 2— " " " "		276
" 4— " " " "		148
" 9— " " " "		33
" 23— " " " "		1
Curculio marked, without rot		
Total defectives		
May 28—Curculio injury of some kind		60
June 2— " " " " "		90
" 4— " " " " "		26
" 9— " " " " "		26
" 23— " " " " "		15
Rot without curculio		

Curculio injury of some kind			217
May 28—With larval galleries		55	
Larvæ present	49		
June 2—With larval galleries		90	
Larvæ present	47		
" 4—With larval galleries		22	
Larvæ present	11		
" 9—With larval galleries		16	
Larvæ present	11		
" 23—With larval galleries		11	
Larvæ present	4		
	122	194	
		122	194
Galleries without larvæ		72	
Feeding or egg punctures only			23

Feeding punctures were specifically noted on 12 fruits only.

A very large percentage of the fruit that dropped on this tree was very small and most of the fruits recorded as sound are probably drops from defective pollination or from mere over-load. The heavy percentage of rot in the early drops is remarkable.

When the fruit was picked, the following record was made by Mr. Blake:

With curculio larvæ	3
Appearance considerably injured	15
Marked, but not commercially injured	97
Perfect fruits	438
Total number of picked fruits	553
Total number of dropped fruits	744
Total number of sets	1297

This means that over 57% of the total set dropped, less than 43% reached full size and that a little over 33.7% of the original set made perfect fruits at ripening.

The number of Curculio marked fruits reached 332, or 25.6% of the whole set, as against 56% on the check, and of those that reached full growth, a little over 25% were marked as against 31% on the check; but only a trifle over 4% were commercially injured.

The comparison with Carman No. 1 is fair and shows a material advantage for the spraying work.

MOUNTAIN ROSE NO. I.

Check Tree Not Sprayed.

June 2—Total drops				4
" 4— " "				3
" 9— " "				10
				18
June 2—Sound fruit	0			
" 4— " "	13			
" 9— " "	20			3
Defective from rot of curculio				1
June 2—More or less rot	34			
" 4— " " " "	1			
" 9— " " " "	82			1
Curculio marked without rot				
Total defectives				1 — 15
June 2—Curculio injury of some kind	36			
" 4— " " " " "	17			
" 9— " " " " "	34		—	8
Rot without curculio				6
Curculio injury of some kind				8
June 2—With larval galleries		35		
Larvæ present	6			
" 4—With larval galleries		17		
Larvæ present	15			
" 9—With larval galleries		18		
Larvæ present	17			
	38	70		70
		38		
Galleries without larvæ		32		
Feeding or egg punctures only				17

Feeding punctures are specifically mentioned in 39 specimens. The larval galleries in almost every instance extended to the pit and might account for the dropping.

At picking time Mr. Blake reported as follows.

Number of fruits with larvæ	00
Fruits badly injured by curculio	18
Injured, but commercially available	117
Perfect fruits	571
Total picked fruits	706
Total dropped fruits	185
Total set	891

This means that of the total set a little over 79% matured and less than 20% dropped from all causes. Not quite 25% of the entire set was in some way injured by the Curculio, and of the fruits that reached full growth, a little more than 19% showed marks of injury. Only a little over 2½% of the final pick was unmarketable.

MOUNTAIN ROSE NO. 2.

SPRAYED WITH ARSENATE OF LEAD, AND SELF-BOILED LIME AND SULPHUR.

June	2—Total drops		62
"	4— " "		32
"	9— " "		86
			180
June	2—Sound fruit	2	
"	4— " "	18	
"	9— " "	18	38
	Defective from rot or curculio		140
June	2—More or less rot	40	
	4— " " " "	3	
	9— " " " "	64	107
	Curculio marked without rot		33
	Total defectives		140
June	2—Curculio injury of some kind	24	
	4— " " " " "	9	
	9— " " " " "	10	43
	Rot without curculio		97

	Curculio injury of some kind.....			
June	2—With larval galleries.....		24	
	Larvæ present.....	5	1	
"	4—With larval galleries.....		8	
	Larvæ present.....	6		
"	9—With larval galleries.....		4	
	Larvæ present.....	2		
		13	36	36
			13	
	Galleries without larvæ.....		23	
	Feeding or egg punctures only.....			7

Feeding punctures are specifically mentioned in 13 cases. Th drops of June 4 consisted largely of small shrivelled fruit apparently the result of defective pollination, and it was some times difficult to determine the presence of curculio marks, et 18 out of 32 were apparently entirely sound.

At picking time Mr. Blake reported as follows:

Number of fruits with larvæ.....	00
Fruits badly injured by curculio.....	2
Injured but commercially available.....	90
Perfect fruits.....	708
Total picked fruits.....	800
Total dropped fruits.....	180
Total set.....	980

This means that of the total set more than 81% matur ... dropped from all causes. A little less tha ... by Curculio in some way or

EARLY CRAWFORD NO. I.

CHECK TREE—NOT SPRAYED.

June	2—Total drops			51
"	4— " "			31
"	9— " "			31
"	23— " "			7
				120
June	2—Sound fruit		0	
"	4— " "		2	
"	9— " "		1	
"	23— " "		2	5
	Defective from rot or curculio			115
ine	2—More or less rot		40	
"	4— " " " "		11	
"	9— " " " "		6	
"	23— " " " "		1	58
	Curculio marked, without rot			57
	Total defectives			115
ne	2—Curculio injury of some kind		50	
"	4— " " " " "		24	
"	9— " " " " "		22	
"	23— " " " " "		4	100
	Rot without curculio			15
	Curculio injury of some kind			100
ne	2—With larval galleries		50	
"	Larvæ present	16		
	4—With larval galleries		22	
"	Larvæ present	21		
	9—With larval galleries		18	
"	Larvæ present	12		
	23—With larval galleries		4	
	Larvæ present	2		
		51	94	94
			51	
	Galleries without larvæ		43	
	Feeding or egg punctures only			6

Feeding punctures are specifically mentioned in 40 cases.

September 3rd, 45 fruits remained on the tree, and Mr. Blake reported on them that 6 were badly and 31 slightly marked, while only 8 were perfect specimens. The percentage of cur-

culio injury it will be noted, is extraordinarily high here, 137
out of 165 recorded fruits being more or less marked and 94
larvæ being actually taken out of the lot.

EARLY CRAWFORD NO. 2.

SPRAYED WITH ARSENATE OF LEAD AND SELF-BOILED LIME AND SULPHUR.

June 2—Total drops			17
" 4— " "			8
" 9— " "			11
" 23— " "			6
			42
June 2—Sound fruit		0	
" 4— " "		0	
" 9— " "		5	
" 23— " "		0	5
Defective from rot or curculio			37
June 2—More or less rot		16	
" 4— " " " "		1	
" 9— " " " "		4	
" 23— " " " "		2	23
Curculio marked, without rot			14
Total defectives			37
June 2—Curculio injury of some kind		17	
" 4— " " " " "		5	
" 9— " " " " "		4	
" 23— " " " " "		2	28
Rot without curculio			9
Curculio injury of some kind			28
June 2—With larval galleries		17	
Larvæ present	4		
" 4—With larval galleries		6	
Larvæ present	6		
" 9—With larval galleries		1	
Larvæ present	1		
" 23—With larval galleries		2	
Larvæ present	1		
	12	26	26
		12	
Galleries without larvæ		14	
Feeding or egg punctures only			2

eeding punctures are specifically mentioned on 5 fruits, one ng as many as 3 punctures. In almost every case the gal- s extended to the pit whether larvæ were present or not. he fruit remaining on the tree September 3rd was picked reported upon by Mr. Blake as follows: None badly, 4 tly marked and 28 perfect. Out of a total recorded set of ruits only 32 showed curculio injury, in marked contrast ie startling percentage recorded for the check tree.

TREE NO. 21, IN 3-YEAR ORCHARD.

SPRAYED WITH ATOMIC SULPHUR + ARSENATE OF LEAD, MAY 3.

ie 4. All dropped peaches found under tree at this date

dropped fruits		271
otted nor marked by curculio		51
Defective in some way		221
More or less rot		161
out rot, but Curculio marked		60
Total defectives		221
ulio injury of some kind		77
Rot without curculio		144
al curculio injury		77
Larval galleries	36	
Larvæ present	34	
leries without larvæ	2	36
Egg or feeding punctures only		41

here were 50 feeding punctures found on 40 fruits.

TREE NO. 23, IN 3-YEAR ORCHARD.

UNSPRAYED.

June 4th. All dropped peaches found under the tree at this date only.

Total dropped fruits		305
Not rotted nor marked by curculio		62
Defective in some way		243
More or less rot		218
Without rot, but curculio marked		25
Total defectives		243
Curculio injury of some kind		89
Rot without Curculio		154
Total curculio injury		89
Larval galleries	54	
Larvæ present	48	54
Galleries without larvæ	6	
Egg or feeding punctures only		35

Feeding punctures are specifically mentioned 38 times.

TREES 7-3 AND 5-3, IN 3-YEAR ORCHARD.

UNSPRAYED.

ne 4. All dropped fruits beneath these 2 trees were picked determine the conditions at this date only.

l dropped fruits		71
rotted nor curculio marked		1
Defective in some way		70
More or less rot		18
iout rot but curculio marked		52
Total defectives		70
ulio injury of some kind		65
Rot without curculio		5
l curculio injury		65
Larval galleries	62	
Larvæ present	54	62
eries without larvæ	8	
Egg or feeding punctures only		3

ere were 30 feeding punctures found on 19 fruits.

3-YEAR ORCHARD—UNSPRAYED TREES.

y 25th. Drops from one tree mostly:—picked up to de- ne their condition at this date.

l number of drops		30
Sound fruit		4
ctive in some way		26
More or less rot		8
iout rot, but curculio marked		18
Total defectives		26
ulio injury of some kind		26
Larval galleries present	26	
Larvæ present	20	
eries without larvæ	6	

irteen (13) feeding punctures were noted in 11 specimens.

3-YEAR ORCHARD: SPRAYED TREES.

PICKED FROM TREE.

May 25. A series of 25 peaches apparently defective, picked from sprayed trees to determine actual conditions.

Total number picked		25
Mechanical or other injury—no rot or curculio		11
No rot—all injured by curculio		14
Galleries developed	8	
Larvæ present	3	
Galleries without larvæ	5	8
With egg or feeding punctures only		6

Five fruits showed one feeding puncture each.

3-YEAR ORCHARD—UNSPRAYED TREES.

May 25. Picked from unsprayed trees merely to ascertain amount and character of infestation.

Total number of fruits			34
Sound fruits			16
Curculio marked			18
Larval galleries		16	
Larvæ present	8		
Egg punctures only		1	
Feeding puncture only		1	18

In this lot there was only a single fruit that showed any feeding puncture.

\R ORCHARD: MIXTURE OF SPRAYED AND UNSPRAYED TREES.

ıy 25. A series of apparently injured peaches picked from rees to determine their actual condition.

al number picked		53
No rot nor curculio injury—otherwise defective		10
h rot or curculio injury		43
More or less rot		11
rot, but curculio marked		32
Total defectives		43
Curculio injury of some kind		43
h larval galleries	41	
Larvæ present	31	41
leries without larvæ	10	
Egg or feeding punctures only		2

feeding puncture was noted on one fruit only.

VOORHEES ORCHARD, HIGH BRIDGE.

SPRAYED.

cked up, June 15, under several trees, to determine condition ops at this season.

al number of drops		86
Sound fruit		5
ective in some way		81
More or less rot		28
hout rot, but curculio marked		53
Total defectives		81
culio injury of some kind		78
Rot without curculio		3
al curculio injury		78
Larval galleries	74	
Larvæ present	65	74
Galleries without larvæ	9	
h egg or feeding punctures only		4

feeding punctures were recorded in 19 specimens.

NEWARK—OLD TREE.

June 13. A series of specimens picked up under an old tree in a Newark backyard to determine cause of drop or infestation.

Total number of fruits		19
Apparently sound		3
With rot or curculio injury		16
More or less rot present		8
Curculio marked, without rot		8
Total defectives		16
Curculio injury of some kind		13
Rot without curculio injury		3
Total curculio injury		13
Larval galleries	8	
Larvæ present	3	
Galleries without larvæ	5	8
With egg or feeding punctures only		5

7 feeding punctures were noted in 4 specimens.

SHADE-TREE INSECTS.

The season has been a hard one on trees of all kinds and especially those in cities and towns. The early warm spell followed by a period of cool wet weather, started most varieties into full and unusually tender foliage. The following period of heat and drought resulted in scalding much of this leafage, and in lowering vitality so much, that shedding or dropping became wide-spread. Where insects or disease had caused previous injury, weather conditions intensified them, until even the most careless owners of trees began to take notice. Inquiries multiplied therefore, from all parts of the State, and while the Elm undoubtedly is the chief victim, many Maples, Poplar and other trees were affected, and made the bases of questions.

Where shade-tree commissions had been established, intelligent inquiry was made, more consultations than ever before were had, and more visits to Cities for the inspection of shade trees were made than in any previous year. The poor condition of the trees in 1910 is directly responsible for several movements in widely separated sections of the State, looking toward organizations for their care.

There has also been formed an organization or Association f Shade Tree Commissions under the auspices of the State orester which will serve to bring about uniformity of action nd will give the newer organizations the benefit of the experi- nce gained by the older bodies. There is, unfortunately, in any cases, a lack of financial support to these commissions, that ndicaps them seriously, and prevents the employment of really mpetent men to look after the trees.

TREE FAKIRS.

This very condition also favors the development of the "tree kir" or "quack." It is a plausible individual always, who lks learnedly of diseases of trees and of insects that attack em, and who has a secret preparation which is absorbed into e circulation and thus renders foliage and wood distasteful to sects of all kinds as well as immune to disease. The price of eatment varies from $1.00 to $10.00 per tree, according to the llibility of the individual, and it varies in method from boring hole to insert the compound and then plugging it up, to scraping e bark and painting the surface of the trunk for a variable stance with a mysterious looking pasty mess.

If all the money spent with these fakirs had been put into roper machinery, some real advantage would have been gained, stead of only a general feeling that all attempts to preserve ees in good conditions are more or less of the fraudulent rder. Fortunately the more general spread of Shade tree and ark Commissions and of Improvement Associations will put a atural termination to the operations of these irresponsible indi- iduals.

It should also be stated that there are now a number of per- ctly responsible organizations, firms and individuals who do mmercial spraying along recognized lines and who must not e confounded with the "fakir" tribe.

ELM LEAF BEETLE.

The elms throughout the season of 1910 suffered severely here they were not thoroughly treated by spraying at the proper ime. The irregular opening of spring resulted in a very ir- egular appearance of the beetles. At first the abnormally warm veather of March brought out a great many of the insects from

their hibernating quarters and the usual crop of specimens was sent in from all over the State, having been found indoors and suspected of designs against clothing, furniture and fixtures. As the weather turned cold and wet in April and May, the beetles disappeared again, and afterward, when the trees began to leaf out, there seemed to be very little feeding and very few of them were seen:—in fact, so scarce did the insect seem to be on the Elms at New Brunswick, that there was a serious question as to whether or not they should be sprayed. Nevertheless, in view of previous experience, I insisted upon the work being done, and many of the city trees and all of the College trees were thoroughly sprayed with Arsenate of Lead beginning about the 10th of May.

The first egg-mass was noted May 12th, but egg-masses appeared to remain very scarce, and certainly there was not much noticeable feeding done by the adults. During the last days of May a second spraying was made on the College trees because of the excessive wet weather and heavy rains of mid-May, and because of the amount of growth that had been made by the trees since the earlier spraying. Throughout early June the Elms remained in fairly good condition everywhere, because of favorable weather conditions and it was not until the latter days of that month, that it appeared that there was a heavy brood of larvæ on the unsprayed trees, and that the characteristic injury began to develop. With the advent of hot and dry weather this injury became greatly intensified, and early in July when the heated term was well established, the attacked Elms began rapidly to show the injury that had actually occurred. Where they had not been sprayed, tree after tree began to turn brown and to shed its leaves. In Cities and Towns where Shade Tree Commissions were established, the sprayed trees retained their foliage in good condition. In Cities and Towns where nothing had been done, by the middle of July the Elms were in a pitiable state. On some streets the trees had practically not a trace of foliage remaining. The result of the injury done during the two previous years now also became apparent, and the defoliation of 1910, accompanied by the pitiless heat and drought, resulted in the dying off of a great many trees. Trees in many places are now so badly injured that recovery will be almost impossible, and it is within bounds to say that hundreds of Elm trees in the State of New Jersey will die before the opening of 1911, or will prove to be so badly injured that they will remain cripples. In strong contrast to the unsprayed trees, those that had been properly cared for during the seasons of 1909 and 1910,

stood out in full foliage, and maintained themselves during the hot dry spell in excellent condition.

On the College Campus, and particularly along the Bleecker Place parking, where the trees had been thoroughly treated in 1909, the results of the work stood out conspicuously. In the first place the janitors had reported very few beetles in the buildings as the consequence of the work of 1909. This was in strong contrast to the conditions where no such work had been done. As I reported in 1909, the largest brood in the history of the State went into hibernation in late July, and while the abnormal weather conditions in the spring of 1910 did undoubtedly result in the destruction of many of the wintering brood, enough remained alive to thoroughly stock the trees near their winter quarters. The College trees thus obtained the benefit of the small local supply, and the prompt treatment in May killed off the remaining beetles before many eggs were laid. During the last days of July, when untreated trees had scarcely a shred of green remaining, the foliage on these trees was almost perfect.

Arsenate of Lead was the material used for all our spraying work except on a series of small trees set out during the season of 1909. These proved to be attractive to the beetles earlier than the larger trees, and they were sprayed with Arsenate of Iron during the first days of May to test the effectiveness of that material as against these insects, in comparison with the Arsenate of Lead. Further details as to this work will be found under a different heading. The large trees were sprayed in part with the ordinary paste form of Arsenate of Lead, and in part with the powdered material put out by the Vreeland Chemical Company. The paste material was also the Vreeland Electro brand, and that was used at the rate of 10 lbs. in the 200 gallon tank. The dry material was used at the rate of 4 lbs. in the 200 gallon tank and that proved to be quite as effective as the paste. Neither of the materials caused injury of any kind to the foliage.

The prediction of 1909 must be, unfortunately, again repeated. An extremely large brood of beetles went into hibernating quarters in midsummer 1910, under the best possible conditions and, unless the coming winter and spring conditions are abnormally unfavorable to the insects, very heavy early feeding and serious later injury may be expected.

A NEW BARK-BEETLE ON ELM.

In addition to the two foreign pests already infesting ou elms—the leaf-beetle and wood-leopard moth—there is now a additional one to be reckoned with. Mr. J. W. Chapman of th Entomological Laboratory of the Bussey Institution at Harvar University, has discovered the European "smaller elm bark beetle," *Scolytus multistriatus* Marsh., in a very large numbe of trees at Cambridge, Massachusetts. From the number o trees attacked and the amount of injury done there is ever reason to believe that the insect has been already firmly estab lished for several years and there is little doubt that it occur over a considerable extent of territory. If it has not yet actuall established itself in New Jersey, there does not seem to be an effective way of keeping it out, and sooner or later it will hav to be dealt with.

Fortunately it seems to be one of those species that doe not attack perfectly healthy trees; but rather those that hav already been impaired in vitality by the attacks of other specie of insects or by disease. Trees kept in good condition are in littl danger; but trees weakened by frequent defoliation by the elm leaf beetle are apt to be excellent subjects for attack and when thi is added to the effects of the defoliation the death of the tree i assured.

That this is not a theoretical fear is only too well demon strated by the number of dead and dying elms in Cambridge.

Like the fruit bark-beetle this insect works in the sappy are between bark and wood. The parent beetle makes a mai gallery with the grain, not cutting the circulation, while th larvæ make galleries more or less across the grain. But th entire area within range of the gallery system is apt to be killed so that, when a considerable number of the beetles are at work a more or less complete girdling is effected.

The attack is usually made well up on the trunk and on th larger branches, so that the insect is not readily discovered from the ground.

The adult beetles come through the bark in June and July and almost immediately begin the work of making new brood gal leries. Apparently there is only a single brood, the larvæ bein of slow growth.

ELM PLANT LOUSE.

In addition to the injury suffered by the trees, from the beetles and the drought, the Elms were also subject in July to the attacks of a plant louse, which found its opportunity to increase in the weather conditions then existing. This particular species of Aphid is not usually abundant enough on the trees to attract attention, and while it may be found each season in small numbers everywhere, it has not heretofore been a factor in lessening the vitality of the trees. The summer of 1910, however, formed ideal conditions for this insect, and about the middle of July it became so abundant that many trees that had been left in fair condition by the beetles, began to show the effects of the work of the louse. This was particularly the case on trees that had been imperfectly sprayed early in the season, and where some injury had been caused by the beetles, or their larvæ. Here the plant lice increased in numbers and began to excrete honey dew, and as the surface of the leaves became covered by the sticky excretion, their function was so greatly interfered with that they simply curled up and died. The ground beneath the trees then became covered with foliage that was sticky on top, partly browned and, on the underside, infested with plant lice. This trouble to a large extent completed the work that was begun by the beetles and resulted in the complete defoliation of some trees that might otherwise have come through in fairly good condition.

THE EUROPEAN RED-TAIL.

Dasychira pudibunda, Linn.

Fig. 7.—Dasychira pudibunda Linn. Female moth. Original.

At the meeting of the Newark Entomological Society February 12, 1909, Mr. Henry Wormsbacher, a member, brought in for examination a single female specimen of a moth which he said he had bred from a collected pupa. I reccognized the insect at once as a European species and, a day or two later, determined it positively as *Dasychira pudibunda* Linn., a form common and widely distributed in continental Europe and parts of Asia, and which has a number of popular names. Because of the red terminal tufts of the larva it is known as the "red-tail"; because of its occasional food-plant it has been called "walnut-spinner," and because of its more common food it is the "beech-spinner." It is one of those species allied to our common vaporer or tussock moth in the habit of extending its tufted forelegs when at rest, and some of the European common names based on this habit, are not readily translated in satisfactory English equivalents.

Because of the seriously injurious character of this species I questioned Mr. Wormsbacher closely as to the source of his specimen, and he gave me a very full description of the conditions under which he collected it, at a point in Bergen County not far north of the Hudson County line.

February 19th, 1909, I sent Mr. H. H. Brehme to make a thorough search in the described locality; but he utterly failed to discover even a single example of the pupa. March 21st, Mr. Brehme again searched the territory, this time in company with Mr. Wormsbacher, and three cocoons were discovered. From one of these a moth emerged March 23rd, in the others the adults developed, but died before emerging. Three times later in the season, July 3rd, July 22nd and September 13th,

)09, Mr. Brehme went over the area on the hunt for caterpillars, ıd at neither time were any found. I concluded that these ıight be accidental occurrences due to a very local and possibly ery recent introduction which would die out for lack of material, nd therefore made no reference to the matter in my report for 909.

In the course of the inspection of stock imported from France luring the winter of 1909-10, one of the inspectors found a ocoon attached to a plant, and from that a perfect female pecimen of this species was bred, which laid a full batch of infertile) eggs. This importing nursery is not more than a nile or two from the place where the cocoons were found the eason before, and the question is now a serious one, whether here is not a slight scattering of the species in this area which annot be readily discovered at present.

The caterpillars are not unlike those of the common tussock ıoth, but much larger and different in color. The head is ellowish, the body ranging from yellowish green to brownish :d, the incisions velvety black. The dorsal brush-like tufts 're yellow or reddish, the posterior hair pencil rosy red and rected backward, justifying the term red-tail. It transforms a yellowish thin cocoon composed of silk and caterpillar hair, a deep brown pupa with red-brown abdomen set with yellowish ıir. The adult flies normally in May and eggs have been found ıtil July.

The young caterpillars grow slowly at first and eat only the)per surface of the leaf; but in August they become voracious ıd then, when they are present in numbers, trees may be sud- enly and completely defoliated. Pupation occurs in late sum- ıer and the larva selects by preference a mossy surface where finds shelter for its dormant stage.

It is a general feeder on deciduous trees of all kinds but favors eech. It also feeds on all sorts of shrubs and undergrowth, oses, small fruits, etc., and is occasionally found on conifers. t frequently defoliates entire forest areas and is recognized as a rst class pest ranking with the Gypsy and Brown-tail Moths.

The habits as above described render the species particularly able to be transported in the pupal stage among the packing sed for nursery stock, and this also makes it difficult to find in rdinary inspection work.

Nothing was seen of the species during the inspections of 910, either in the nursery or in the vicinity; but this is not con- incing proof that it does not occur, and the locality must be ept under close observation.

MISCELLANEOUS SHADE AND FOREST INSECTS

The *White-marked Tussock* or *Vaporer* moth was very much in evidence on shade trees this year, especially in the western part of the State and along the Delaware River cities and towns. Camden was especially infested and on some streets practically all the trees had the foliage seriously injured. Mr. Dickerson noted egg-masses everywhere, on August 2nd. In other sections of the State the infestation was not so obvious; but was more serious than usual, perhaps because of the drought which intensified the injury.

This is one of those species against which the co-operation of the tree owner should be sought by the authorities in charge of shade tree work. So much can be done to reduce the species by picking off and destroying the egg masses that, were the work done by *all* tree owners, the number of specimens would be materially reduced. Incidentally, in those cities where the trees are sprayed, very few of these caterpillars were noted.

The *Maple false* scale, *Pseudococcus aceris,* was very oddly local during the season. In almost every city and town it occurred to some extent, sometimes where it had never been before; but almost always on only a few trees here and there.

In New Brunswick it occurred on trees where I had never seen it before, while on such as it had infested in past years, it was often absent. In some cases only one or two trees in a row were attacked, in others every tree would have some infestation.

The conditions elsewhere, were much the same and this species was responsible for as much new correspondence as any other, during the season. The hose and plenty of water under pressure was always advised where possible and was always reported as effective where any report at all was made. It was interesting to note that the leaves were nowhere so much attacked as in years past, and not a single sample of that form of infestation was sent in.

The *Cottony Maple Scale* is again beginning to increase in numbers in the eastern section of the State and was noted at Rahway by the Shade Tree Commission and at Springfield and Rutherford by Mr. Dickerson. Some parasites were found in connection with the Rutherford material and it may not be for several years to come that any general infestation is again established.

The tulip soft scale, *Lecanium tulipifera,* was as frequently reported as usual, and generally on young trees. It is the only drawback to this fine tree and, unfortunately, is not easily dealt with. The scale is a peculiarly nasty one in its partly grown stage in early spring, while its huge size and the sticky excretions just before maturing make it offensive to many persons.

Yet, on small trees, a mechanical cleaning in early summer is the best method of getting rid of them completely. They winter in the young larval stage and can be fairly well reached at that time with the miscible oils. It may be that the lime and sulphur combination is equally effective; but that has not been tested to my knowledge.

On poplar, especially on young trees in nurseries, a leaf-beetle, *Lina scripta,* has been unusually destructive and has defoliated many of the smaller trees. It feeds equally on willows and is usually more abundant on them; but this season poplar was undoubtedly the favorite. It was not confined to any one section or area; but seemed everywhere to find conditions to its liking. It is two brooded, feeds ravenously in the larval stage, and the nurserymen found treatment imperative.

Fortunately the insects feed entirely exposed in all stages and succumb readily to stiff doses of arsenate of lead, properly applied.

The *hickory bark-beetle* was more than ever complained of, and the State Forester was probably as often applied to in this connection as I was. Usually the infested trees stand singly or in small groups, on a lawn or in a park, and are survivors remaining of the original woodland out of which the park or settlement was cut. Such trees are rarely quite healthy and are, of course, under abnormal conditions predisposing them to attack of this kind. Furthermore the attack is not usually noticed until the infestation has become serious, and then the fate of the tree is sealed.

There is simply nothing to be done for a tree of this kind. When once the infestation is well established the tree might as well be cut out at once, so that it may not become a source of danger to others. Where the tree stands alone, endangering no others of its kind, it can be left if desired, until it dies.

Where there is only one of a group attacked, that tree should be cut out at once and the wood used immediately. If the trunk is left the beetles may reach maturity and emerge, ready to attack the most susceptible of the survivors. The beetles emerge in the spring and have the habit of boring into the leaf petioles for food. This is the only chance of reaching them with stomach poisons

and if the trees are thoroughly sprayed with arsenate of lead spring, just when the adult beetles are emerging, there is a go chance of poisoning a large portion of them.

Mr. J. J. Levison, of the Brooklyn Park service has had th problem to deal with in the parks under his care, and has fou the most radical measures the most satisfactory. He has c out every tree showing any signs of infestation and has spray the remainder as above. It has cost about a hundred trees; b there are several hundred yet remaining, and for these t source of danger has been removed. A single tree once tho oughly infested cannot be saved; but the sacrifice of one or tw trees of a group may often save the remainder. It should al be remembered that hickories do not grow naturally in the op and in a sod, and that starvation and lack of moisture tend get these trees into a condition that renders them an easy a attractive prey to any wandering female *Scolytus quadrispinos* that comes along.

The bronze birch borer, *Agrilus anxius* Gory, has not extend its range beyond that reported last season. In the block se me by Mr. Solotaroff, adults were fully developed in early Ma although there were also some pupæ and a very few lar remaining. The beetles began to emerge in the breeding ca in June and living specimens were found until early July. is probable however that under normal, out-door condition practically all the beetles would emerge in early June and th before the beginning of July oviposition would have been com pleted.

Chestnut trees in many portions of the State are succumbing with alarming rapidity to the canker disease, the cultivated va rieties seeming more resistant than the native. Altho the char acter of the disease has been described in the newspapers a well as agricultural and other journals dealing with country life, many correspondents are insistent that the injury is due to insect attack.

The larva of the two-striped chestnut borer, *Agrilus bilineatus* is not infrequently sent in and charged with the mischief and no doubt, the galleries of this insect do in some cases give admis sion to the disease. But the number of these larvæ found a any time is ridiculously inadequate to produce the results charge against them.

A better case was made in one instance during the early par of the season against the giant root-borer, the larva of *Prionus laticollis*. The trees had died with all the marks of the canke and were sorrowfully cut down. In cutting down into th

roots many of them were found bored by these immense larvæ and word was sent to the office at once. Mr. Grossbeck was sent to investigate and reports that while there were, undoubtedly, many borers in some of the partly decayed roots, the main root-system was sound and the death of the trees could not be charged to these borers.

The pests are quite general feeders and occur in the roots of many trees and plants. Fortunately they are rarely abundant enough to cause serious trouble, and they require three years to come to maturity.

Oak was less troubled than any other of the forest trees remaining on lawns or in parks, and complaints were confined to the golden oak-scale, *Asterolecanium quercicola,* and the oak-pruners, *Elaphidion* species.

The scale insects were never very abundant and usually on isolated trees; but attracted attention by their golden color where clustered closely on a small twig.

The "pruners" were perhaps a little more conspicuous than usual but did no real harm. In fact these and some other sendings really show less an unusual infestation, than an awakening on the part of tree owners to the fact that trees are attacked by insect pests that it might be well to know about.

Unusual attention was paid to conifers during the season. In the first place the danger of introducing the blister rust of the white pine made the inspection of recent plantings desirable and, while that is not an entomological matter in any way, there was no one else that was in any position to do it. In the course of this inspection it developed that there was on the young trees a quite considerable infestation of a *Chermes* species, sufficient in some instances to destroy or seriously cripple them. An inspection made on the plantings of the Newark Watershed early in May showed that very markedly, and there is no doubt that a large percentage of the planting has been seriously retarded. The affected plants were easily recognized by their stunted appearance, the shortness of the leaves, which were not over half as long as those not affected, and by an unnatural brownish tint. An application of whale oil soap and "Nico-Sul" was advised and proved effective, as I am informed.

In nurseries and in parks and private gardens, three species of gall-lice were found on spruces, in considerable numbers. Little attention has been paid to these insects in New Jersey, and a further and more careful investigation is desirable. The species occurring in Maine have been recently well studied by Miss Edith M. Patch, and her work will make an excellent point

of departure for further knowledge of the species occurring with us.

In 1894 the *periodical Cicada,* Brood XII, as it was then known, appeared over a large part of New Jersey and proved to be perhaps the largest and most widely distributed of those occurring with us. Its distribution was worked out and recorded in the report for that year, and the curious chimney building habits were there described.

Studies made within recent years have resulted in a change in the numbering of the broods, and what was brood XII, (Riley) in 1894, is now Brood II (Marlatt).

As a warning to orchardists, a circular was sent to all newspapers and to the entire Bulletin list early in August, calling attention to the fact that 1911 will be "Locust" year. The advice given was that where the insects occurred in large colonies, orchards should not be severely pruned and that young trees if set out at all, should not be much cut back until after the insects had disappeared.

In mid October just after the rains I received a letter from Mrs. E. S. Starr of Ocean View, describing an "eruption" of small cones or hills over a large area of open sand field near by. There was no doubt as to the character of these cones and I sent Mr. H. H. Brehme down to make further examinations and to determine the area over which the work of the insects extended. He found that there were literally square miles of cone-covered surfaces and simply millions of cones. None of them were open at the top and the little mounds were composed in almost every instance of the soil coming from a depth of six inches or more—the damp yellowish clayey layer below the white surface sand. The tunnels were almost half an inch in diameter and extended many feet beneath the surface. It was intended to carry the studies further, but a heavy rain storm destroyed the hillocks and made it necessary to postpone operations. At all events there is no doubt that the Cicadas are on time and will make their appearance in 1911, as per schedule.

INSECTS INJURIOUS TO FIELD CROPS.

The annual tax taken by insects on the ordinary field crops, is not usually reported by the farmer. It is so much a matter of course to have "potato bugs," "cabbage worms," "asparagus beetles" and the like, that they are dealt with in a routine way and complained of only when they occur in abnormal numbers.

The clover-leaf beetle is one of those species so well kept in check by natural conditions, that most farmers do not know it at all. Very occasionally the check is delayed by adverse weather conditions and then, what seems to be a new danger, makes its appearance. The droughty conditions of early April after the abnormally high temperatures of March gave clover an excellent start, favored the rapid early growth of the beetle larvæ and then delayed the development of the check disease. Injury began to show about April 20th and over considerable areas the fields began to look as if a hail storm had struck them —so many leaves had irregular holes in them. A timely rain gave the disease a chance, and on April 25th while larvæ, half to full grown could be readily found, they were mostly sick and the danger was over. A few days later it was almost impossible to find a living larva, altho their dry, black remnants were abundantly visible.

The *army-worm* was much reduced in numbers as compared with the two seasons last past and only in Cumberland County were they plentiful enough at any point to go on the march in mid-June. They were met in the usual way with ditches and plowed barriers and confined in almost every case to the point of origin.

Cut worms occurred early in the season in destructive numbers throughout the State and caused serious injury to early truck crops. There was a quite general resort to the poisoned bran remedy and usually with good effect. So generally indeed was the material used and in such abundance, that it attracted the attention of some of the bird friends and led them to threaten indictments for bird poisoning if the practice was not discontinued. There was no claim that any birds wanted the cut-worms or that injury to the birds would be caused by eating cut-worms killed by the poisoned bran. There was simply the suggestion, without a particle of proof, that some birds might be killed by eating the bran intended for the worms.

It was seriously demanded, therefore, that the farmers permit their crops to be destroyed by cut-worms so as to avoid possible danger to birds who would not touch a worm if it was offered them. Needless to say that no attention was paid to the demands, the cut-worms were fought with poisoned bran, and no indictments were found.

One case came under notice where the poisoned bran failed. This was in late August and the crop was lettuce, locality Cumberland County. The species was one of those that develops a second brood late in the summer and was probably the "greasy

cut-worm," *Agrotis ypsilon.* The field of lettuce had b thinned out and left for several days, and the cut-worms started in from one edge and corner, sweeping over a la area before means were taken to reach them. They were t in such numbers that a dozen could be readily turned out v the finger run along the plant rows. Bran, paris green sugar were used, but failed to act rapidly enough or to exer greater attraction than the succulent lettuce. So the let itself was poisoned where the worms occurred, and a few d thereafter Mr. Dickerson found only dead specimens. The here was estimated at $2,000, most of which could have b prevented had the insects been discovered early enough, when they first entered the lettuce patch. Cut-worm injury late in the summer is unusual and not anticipated, as the ea spring attacks had been satisfactorily dealt with.

ROOT MAGGOT OBSERVATIONS.*

Root maggots were as abundant as usual during the year and onions in particular suffered from their attacks. No experiments in controlling them were made, but as opportunity served the insects were noted in the field. As heretofore, our principal observations were made at Mercerville and Husted, and the following record is given of the conditions as they were found at those places.

CONDITIONS AT MERCERVILLE.

November 11th, 1909, after the notes for last report were closed, the Riley farm, where turnips had been found infested somewhat earlier was visited. Many turnips had been pulled, but part of them still remained in the ground and in these a few well developed maggots were found. The majority of the maggots, however, had pupated. A number of these pupæ were observed and it was noted that while they evidently had no particular position in the soil, they usually occurred at a depth of 4-5 inches: sometimes nearer the surface. The interesting fact was that from a few of these puparia flies had emerged, and that may indicate that some at least hibernate as adults.

An examination of the wild radishes near at hand showed more maggots in a similar condition. On several of the young radishes among the young leaves near the center of the plants, recently laid eggs were found; usually only a few, but in one instance a dozen or so. They had evidently been placed there by flies emerging from puparia just noted. No flies, however, could be found about the patch. On November 18th, the place was again visited but no evidence of more egg laying was found and while a careful search was made for adults, none were seen. A further examination of the wild radishes showed that large numbers of them had served as breeding places for the maggots.

During the present year (1910), the Black place was first visited on May 2nd, and the cabbage plants which were some little distance from those of last year, were carefully examined. Eggs were observed about many of them and a very few young maggots noted. A number of male flies were obtained and a few

*By Mr. E. L. Dickerson.

females. Some of these adults looked worn, and apparently oviposition had been going on for over a week. But it was still in progress, as eggs were found in one of the females captured. It looked as if there might be a rather bad infestation, but when I again saw the plants, May 17th, it was not nearly as bad as had been anticipated. It may be that the single treatment of carbolic acid and lime, given shortly after I last visited the place, was accountable, in part at least, for the results, because the cabbage plants on the Riley place, where no treatment had been made, were found to be decidedly worse infested. Most of the maggots were well developed, but there were some small ones, showing irregularity of development.

When conditions were noted on the Black farm, June 29th, it was found that maggots were feeding in a large number of the wild radishes growing about the place. The maggots were for the most part well developed, but some only partly grown, and a few were very small and recently hatched. Apparently the majority of eggs had been laid early in the month, and that explained why the maggots were found for the most part in the older plants. That these maggots came from eggs oviposited by flies bred from the maggots noted in the cabbage in May, is also quite evident, for from some of the maggots obtained from the cabbage plants on May 17th and placed in outdoor cages under natural conditions, flies were bred as follows:

	Black Patch.		Riley Patch.	
June 8	2 ♂ & 2 ♀	*brassicae* & 1 ♂ *fusiceps*	2 ♀	*brassicae*
" 10	2 ♂	"	2 ♀	"
" 11	3 ♀	"	1 ♂ & 1 ♀	"
" 12	1 ♀	"	1 ♀	"

It is very probable that I did not get the earliest developing maggots on the cabbage in May, and some flies of the above brood were around earlier than noted by the above emergences. When these flies came out the cabbages had grown too old and tough to serve as places of oviposition, and as there were no other cultivated cruciferous crops, the flies naturally sought the wild radishes growing about the place.

When on September 16th, the Riley farm was visited and the turnips, the only cruciferous crop being grown at that time, were examined, they were found as in previous years to be infested. The stand, on the whole, looked good and showed only

ıall amount of maggot injury, but search around the plants ıled eggs about many of them: scarcely any or none around : plants; several about others. In some cases the eggs had hed, in other instances they appeared to be still in good ition although somewhat mixed with the soil. In a few ; the eggs were observed still attached to the turnips. The gots for the most part were small, although a few large were found in some nearby radishes. Flies in very small bers could be found throughout the patch.

nother examination of these turnips on October 8th, showed of them more or less infested. In most cases the maggots fed on the outside and had not bored through the bulb; but ı this outer surface was badly eaten. Although a few small gots were noted, they were for the most part full grown, and ry few pupæ were observed. Across the narrow roadway ı these turnips, a number of wild radishes growing in a patch gg plants were found to be even worse infested than the ps; two or three dozen maggots in some of the roots. They in the same stages as those on the turnips.

ıe question as to the source of flies which laid the eggs ucing this brood of maggots was answered by breeding, in ; in the ground, under natural conditions, maggots infesting ıge in May and wild radishes in June. Adults were ob- d from the former in June as noted previously, but adults also obtained from both lots in September as follows:

ots Infesting Cabbage in May.		Maggots Infesting Wild Radishes in June.	
Black.	Riley.		
7...3 ♂ & 3 ♀ *brassicae*	4 ♂ brassicae.	2 ♂ & 5 ♀ *brassicae.*	
... 1 ♀ *fusiceps*			
10...	2 ♀ *brassicae*	2 ♀ *brassicae*	
	1 ♀ *fusiceps.*		

ıe maggots feeding in these turnips will, for the greater at least, pass the winter as puparia. This we have noted iously.

CONDITIONS AT HUSTED.

On the Seabrook place no cruciferous crops were grown in the fall of 1909, as it was thought that by doing away with maggot breeding places at that time, an infestation in the spring of 1910 might be prevented or greatly reduced. Nevertheless, when they were pulling radishes as early as April 17th, 1910, maggots were noted in them and when, on May 9th, I visited the place and examined the radishes, some small and many well developed maggots were found, while some had evidently pupated as indicated by the condition of the roots. About the patch, flies of what appeared to be *fusiceps* were noted. The cabbage plants were in an apparently good condition and when examined a few days previous had showed only a very slight infestation.

In the scallions some infestation had been noted very early in the season, but on May 9th, in their larger onions, scarcely an infestation was noted, and while the smaller onions which had recently come up from seed showed a slight infestation, the plot as a whole was making a fine stand. A number of the adults flying about the patch appeared to be in good condition and the females were well filled with eggs.

On July 13th, the Seabrook place was again visited in response to a report that maggots were very abundant. The onion maggot flies noted on May 9th, were evidently the earliest of an emerging brood, and found ample opportunity for oviposition; for the large onions previously noted in good condition had become so badly infested that a fourth to a fifth of the crop was destroyed. Seedling onions suffered even worse. A lot sown May 20th, was practically all destroyed, while two plots sown earlier in that month suffered a somewhat less infestation, and of these latter the plot in which the seed had been sown thickest suffered worst. Taking it altogether a large proportion of the onion seedlings had been destroyed. On July 13th, numbers of full grown maggots could be found, but even a larger number had pupated, while a few of the flies could be seen.

The early cabbage had remained free from infestation but, that set about June 1st, was half destroyed.

In the radishes the maggots continued, and one lot became infested late in June. Mr. Seabrook said that this was later than they had ever noted them in radishes and that, on the whole, the maggots were unusually troublesome.

In the conditions here noted on the Seabrook place two points are of particular interest. The one is that even though no

ıciferous plants were grown during the fall of 1909, never-
ɛless the place was badly infested in 1910. The flies, pro-
cing the maggots causing the 1910 infestation came either
ɔm maggots infesting crops on the place in the spring or sum-
ɛr of 1909, or from maggots infesting wild radishes in the
mmer or fall of 1909. If the former is true then the puparia
d laid over for several months and had not been seriously
sturbed by cultivation, as the ground on the Seabrook farm is
ntinuously worked. If the latter is true then the infestation
me from outside, as their own farm is so clean that no wild
dishes ever get a foothold upon it.

The other point of interest in connection with this serious in-
station was that an overhead irrigation system had recently
en installed and during the season the various plots were
ore or less continuously irrigated. Several times I have
sted the effect of dryness on the eggs of these insects and found
at when kept moist they hatched, but when allowed to dry out
ey failed to do so. This leads to the suggestion that the over-
ad irrigation while beneficial to the crop, may also be beneficial
the insects in the egg stage and so far as the maggot is con-
rned may be bad practice.

BREEDING IN WILD RADISHES.

One of the points connected with the root maggot which it
as felt desirable to determine, was its natural breeding place.
ccordingly, as opportunity served, wild radishes were examined
roughout the State. The conditions at Mercerville have already
en noted. On both the Riley and Black farms the wild radish
ows more or less abundantly, and serves as a natural breeding
ıce for thousands of root maggots at all seasons.

On September 30th, at Eatontown, a number of wild radishes,
ɔwing in a nursery, were found to be much infested by well
veloped maggots. And again at Freehold on October 5th,
similar lot of plants growing in a field were found to be in
ge part infested. Infested plants have also been found at
ıtherford, Red Bank and Woodstown. These observations
int to the fact that the wild radish forms the great natural
ɛeding place for these insects. It is a common weed and
ows abundantly throughout the State. Its destruction on any
rticular farm will undoubtedly help to check the numbers of
eeding maggots, but it is so widely distributed that there is
ways more or less probability of plants sown or set in fresh

places becoming infested. Nevertheless its destruction is good practice and to be recommended.

Whether both species, *brassicae* and *fusiceps*, breed in the wild radish in equal numbers is unknown. The latter species is recorded as breeding in a rather wide range of plants and without doubt breeds in this one. During the past season the few examples which we bred from maggots infesting the wild radish were all *brassicae*. A number more of these maggots, however, are being carried over at the present time to determine this point.

CONCLUSIONS.

Nothing new in the way of remedial measures was developed. From the conditions noted at Mercerville it appears, that the single spraying of lime and carbolic acid mixture made at just the right time may have been of some value. At Richfield, Passaic County, one of the growers had again tried gas tar and sand about the cabbage and cauliflower plants, with fairly good results. He believes he would have had better results had he not been a week late in using it. The condition of the maggot breeding in wild radishes also suggests the desirability of keeping these plants in check. Present indications point to the fact that while some flies live through the winter and oviposit in spring, hibernation may be in any larval or the pupal stage. Growth continues until hard frost and pupation may take place at any time in late fall, during a mild spell in winter or in the early spring.

BENEFICIAL INSECTS.

Nothing was seen during the summer of the egg-parasite of the elm-leaf beetle, *Tetrastichus xanthomelaenae* Rond., and no new colonies were received for distribution. There was excellent opportunity, too, for any enemy of that species to establish itself!

The Chinese Mantid, on the other hand, *Tenodera sinensis*, has been found at several points in the State where it has been introduced, and indications are that it has become really a citizen of the State. Several specimens were seen at New Brunswick, one at quite a distance from the point of introduction, one dropped on the hat of a collector in the Orange Mountains, and several were reported at different other points: all accidental views of a species not given to coming out too actively into the open.

At Anglesea and vicinity the species thrives, but no search for it has yet been made on the mainland, where also it was introduced.

In the report for 1909, record was made of the placing of egg-masses in Dover Township, north of Toms River. That colony was visited by Mr. Brehme November 10th, and 17 egg-masses were seen within a short time, two of them a quarter of a mile from the point of setting out. That indicates a considerable spread by the insect, and indicates also that the surroundings favored it. As the shrubbery and oak scrub were still quite full of foliage, the egg-masses were not easily found and the discovery of so many in so short a time argues a considerably greater number present.

INSECTICIDES.

No systematic experiments with the multitude of new materials now coming on the market annually are possible at any one point. Yet it is very desirable that some effort be made to secure reliable information concerning some of the materials offered to the farmer.

Legislation in many of the States prescribes the requirements for Paris Green, and in New Jersey some attempt is made to regulate its sale. For two years an appropriation was made for the purpose of analyzing insecticides, and bulletins containing such analyses were published. The withdrawal of the appropriation has made systematic sampling and analyses impossible and no bulletin will be published this year.

During the last session of Congress a law was passed and approved by the President, which regulated the manufacture and sale of insecticides in interstate commerce on the lines of the pure food and drugs law and prescribed the requirements of a pure paris green and arsenate of lead. Adulterations and misbrandings are forbidden, and penalties are provided for offering insecticides containing arsenic where the arsenical content is not stated.

This law will, no doubt, result in much more uniform products and, as a matter of fact, most of the arsenical poisons now offered by reputable manufacturers are of good grade and satisfactory price.

In co-operation with the Chemical Department, all the makes of arsenate of lead offered for sale in New Jersey were sampled during the season, except the Electro brand made by the Vreeland Chemical Company, and were analyzed with the following results:

DESCRIPTION OF SAMPLES.

Sample Number.	MANUFACTURER.	Container.	Gross Weight.	NET WEIGHT	
				Total.	Paste.
			Lbs.	Lbs.	Lbs.
1	Swift's—Merrimac Chemical Co.....	Glass.	1.84	1.08	1.06
2	Disparene—Bowker Insecticide Co.....	Glass.	2.93	1.93	1.81
3	New Process—Sherwin & Williams Co....	Glass.	1.63	1.22	1.22
4	Orchard Brand—Thomson Chem. Co.....	Tin.	1.17	1.02	0.96
5	Eagle Brand—Adler Color & Chem. Wks.	Tin.	5.25	4.82	4.82
6	Anchor Brand—Leggett & Bro.....	Tin.	1.17	1.01	1.00
7	Star Brand—F. L. Lavenberg.....	Tin.	1.18	0.98	0.98
8	*—Grasselli Chemical Co.....	.....	.....	.....	.....
9	† Paste, Grasselli Chemical Co.....	Glass.	.....	.....	.....

*Subsample from Brooklyn Park Department.
†Jar cracked.

ANALYSES OF ARSENATE OF LEAD.

Original Material (Paste).

Station Number.	BRAND.	Water. (H_2O).	Arsenic Oxid (As_2O_5).	Lead Oxid (Pb O)	Soluble Arsenic Oxid. (As_2O_5)	Soluble Impurities—Exclusive of Soluble. (As_2O_5).
		%	%	%	%	%
1	Swift's	48.86	16.25	31.96	0.20	1.13
2	Disparene	35.24	20.02	40.00	0.25	1.17
3	New Process—Sherwin & Williams Co.	53.51	11.54	31.61	0.18	0.75
4	Orchard Brand	44.65	15.22	35.68	0.14	3.18
5	Eagle Brand	45.78	16.09	35.00	0.14	0.68
6	Anchor Brand	48.77	15.84	32.69	0.20	1.03
7	Star Brand	40.51	16.89	39.47	0.15	1.63
8	*Grasselli Chemical Co.	42.14	16.45	38.62	0.15	0.89
9	†Paste—Grasselli Chemical Co.	39.10	17.15	40.35	0.08	0.90

*Subsample.
†Jar cracked.

ANALYSES OF ARSENATE OF LEAD.

Dry Basis.

Sample Number.	BRAND.	Arsenic Oxid (As 05). 2	Lead Oxid (Pb 0).	Soluble Arsenic Oxid (As 05). 2	Soluble Impurities Exclusive of Soluble (As 05).
		%	%	%	%
1	Swift's	31.77	62.49	0.39	2.2
2	Disparene	30.92	61.77	0.39	1.8
3	New Process—Sherwin & Williams Co.	24.83	67.99	0.39	1.6
4	Orchard Brand	27.49	64.46	0.26	5.7
5	Eagle Brand	29.67	64.55	0.26	1.54
6	Anchor Brand	30.91	63.81	0.39	2.01
7	Star Brand	28.23	66.35	0.26	2.74
8	*Grasselli Chemical Co.	28.43	66.74	0.26	1.54
9	†Paste, Grasselli Chemical Co.	28.16	66.24	0.13	1.47

*Subsample.
†Jar Cracked.

The Vreeland Electro brand arsenate of lead was used in a[illegible] the work done by the Station and in spraying elms, and wa[illegible] analyzed from samples of the material furnished, dry and paste[illegible]. It was also represented in a lot of samples received from an[illegible] analyzed for a shade tree commission and in all cases the arse[illegible] nic oxide was close to 20% for the paste and 34% for the dr[illegible] powder, with less than ½% of soluble arsenic.

The Vreeland dry arsenate of lead was used in comparis[illegible] with the paste of the same manufacturer against the elm le[illegible] beetle on the College trees, as elsewhere recorded. It was us[illegible] at half the weight and its effects were equal in every respe[illegible]. No trace of injury to foliage appeared at any time.

Three apple trees in my own garden were also sprayed wi[illegible] the powdered material May 13th, and literally drenched. The[illegible]

; no injury of any kind to foliage, and the results as against
ling moth were all that could be desired. There was scarcely
ormy apple at harvest and very few indeed were noted among
drops.

believe this dry arsenate of lead to be a great advance over
paste form heretofore in use. It does not deteriorate in
ping, it is less bulky, there is no waste weight of water and
ıixes up even more readily than the paste. I have made no
mpt to use it dry through a sifter, powder gun or the like,
see no reason why it could not be so used wherever dry paris
en has been used. It contains about 34% of arsenic as against
% in good paris green.

\t two points in Cumberland County arsenate of lead, brand
nown, was used against asparagus beetles and their larvæ
ı excellent success. The applications were made by rule of
mb, just a "strong mixture," but the quantity was evidently
icient. Mr. Dickerson who saw one of the fields in October,
s that traces of the poison were still apparent, and that the
ıts in the sprayed rows were from 1/3 to ½ larger than
se not sprayed. It has not heretofore been considered feas-
to spray the feathery foliage of asparagus, and as a rule the
gs of the second brood have been permitted to develop un-
cked. This has always caused more or less stunting in
wth and perhaps a lessening of yield.

ATOMIC SULPHUR.

Jnder this term the Thomsen Chemical Company supplied a
ıll quantity of what they described as a combination of arse-
e of lead and sulphur. Most of the material was turned over
Mr. Blake for use in his spraying work in the peach orchard,
in another portion of this report some of the results so far as
culio injury is concerned are given.

)n my own peach trees I applied a heavy dose May 18th, 1910,
n the fruit was already well developed, and the material was
ly intended primarily as a fungicide, since curculio injury
ny peaches had never been obvious enough to call for treat-
ıt. The prune tree on which the fruit quite generally rots
also sprayed at the same time. The material mixed well
stuck well to the fruits. No injury was caused to fruit or
age, but on the varieties ripening in July and early August
ever had cleaner and finer fruit, almost absolutely free from
: or scab. I did not see the fruit from the late varieties and
not speak as to these.

The prunes did not rot nearly as much as in previous years but the dry weather was against them and a large percentage shrivelled and dropped. This material is well worth further and more systematic trial, and promises to fill a real need.

ARSENATE OF IRON.

This is a material that has been recently recommended in some European and especially French, publications. It is said to be quite harmless to plant life and indeed, through the iron, rather a stimulant than otherwise. It is also recommended as very cheap and quite as effective as the more expensive arsenites.

At the suggestion of the E. B. Voorhees Agricultural Club I arranged for a series of experiments to be made by the members, who are graduates of the Short Course. The material was supplied by the Station and the following circular of instructions was sent:—

HOW TO PREPARE ARSENATE OF IRON.

"Dissolve 1 pound of arsenate of soda in 4 gallons of water in a wooden tub or barrel. (Solution A).

Dissolve 1 pound sulphate of iron in 4 gallons of water in a wooden pail or tub. (Solution B).

Pour the dissolved suphate of iron (Solution B) slowly into the dissolved arsenate of soda (Solution A), stirring continually to get a complete mixture.

After 3½ gallons of the sulphate of iron have been poured in, test the mixture from time to time with potassium ferricyanid test paper, until the latter turns blue. When this occurs the arsenate of soda is completely neutralized and no more sulphate of iron solution should be added.

This forms the stock mixture and may be diluted to 50 gallons by adding water and stirring. The diluted mixture is the equivalent of 1 pound of paris green, or from 2 to 3 pounds of arsenate of lead, in 50 gallons of water and, if properly prepared, is said to be as harmless as the latter, to foliage. It is also quite as adhesive and has a characteristic color that is not easily mistaken for anything else.

The material has not been tested on peach foliage, and should be cautiously used on tender foliage generally.

If possible the material should be used at different dilutions to try and get its minimum effective strength. Using the 50 gallons as a maximum, for instance, if the application is against

tato bugs, spray say one row at full strength, one row diluted 60 gallons, one row diluted to 70 gallons and so on until the ution of 100 gallons is reached or just half the maximum engtb.

Note carefully the strength used in each row and after 24 urs note the difference in effect.

This arsenate of iron is a stomach poison like paris green d arsenate of lead, is to be used like those materials and is ective only against chewing insects."

Seven lots of material were sent out and were acknowledged, h the promise that I would be kept posted as to applications d results. No attempt was made to supervise applications, d at the end of the season the net results were very slim. In ne instances the insects did not turn up in sufficient numbers invite treatment and in others there were other excuses.

The most complete report is sent in by Mr. R. S. Schomp, Princeton, who says: "The materials were mixed according directions; using enough to make 100 gallons (2 lbs. of each redient were used), then this mixture sprayed an potato es under 100 lbs. pressure. The balance of the potatoes were ayed with the ordinary bordeaux and arsenate of lead mix- e. The potatoes were sprayed in this way 2 or 3 times. ey should have been sprayed oftener. The vines sprayed with arsenate of iron showed the effects of the blight a little more n those sprayed with the bordeaux. The bugs were no worse the vines covered with iron than on those covered with bor- ux and lead. The potatoes sprayed with iron were somewhat bby; more so than the others."

As no fungicidal effect was anticipated from the iron, the ater amount of blight as compared with the bordeaux mix- e is not disappointing. The amount of scab on different rtions of the plot must be due to some factor other than the ference of the material applied to the leaves.

Mr. A. Schieferstein, of Rahway, reports:—"The Arsenate of n was used at strength of 1-50 and whole field sprayed once. fixed the potato beetles, whereas Pyrox was not effective ainst them." Unfortunately no later applications were made cause a change of employment left the farm in other hands.

The application made by Mr. George W. Horn of Newton as indefinite and a very small quantity only. Such as it was, believes that it did not kill quite as well as Paris green at the te of a "teaspoon of green to a pint of water."

In addition to the large elms on the College Campus and along ie streets, a considerable number of small trees were set out

two years ago and these proved very attractive to the elm beetles when they came out of their winter quarters. They needed treatment before the large trees did and I had two of the senior students make the application of arsenate of iron, under Mr. Dickerson's direction. The injury was checked at once, a few egg clusters appeared on the trees later and the beetles disappeared in a few days. There was no larval injury and there was no injury done by the insecticide.

Two branches of elm, one sprayed with arsenate of iron, one not sprayed were brought into the laboratory, placed in a large jar and a number of beetles were introduced into each jar. Unfortunately, as it appeared, all the beetles had been taken from sprayed trees and died within two or three days thereafter. The sprayed leaves had not been fed upon at all: the unsprayed branch had seven leaves with one, two or three small feeding holes. There were 12 beetles with the unsprayed foliage, 9 with the treated leaves. No eggs were laid by either lot.

"BLACK LEAF 40."

A considerable quantity of this material—12, 2½ lb. cans—was supplied by The Kentucky Tobacco Product Co., for experimental purposes, under the name "Nico-Sul"; a name it was necessary to change because it proved to be preoccupied.

I used seven of the cans for the co-operative experiments with members of the E. B. Voorhees Agricultural Club, and the outcome was much the same as in the case of the arsenate of iron. Two cans were sent to others who have not yet reported, and small quantities were given to various persons who came in for help against plant lice in gardens, etc.

As to the latter the record is of unbroken success—it seems certain that this sulphate of nicotine is fatal to plant lice of all kinds and it is only a matter of proper application and proportion. To the members of the club, the following sheet of instructions was sent:

"NICO-SUL."

"This is a tobacco extract in the form of Sulphate of Nicotine, highly concentrated, containing 40% nicotine, and effective as a contact poison against plant lice and sucking insects generally.

It is desired to test the material at various strengths against different kinds of plant lice, larvæ of scale insects and leaf hoppers.

ıe strengths at which it may be expected to be effective —

ɣainst green plant lice on roses, apples, peach, melons, cabbage and other plants, at the rate of one (1) ounce in ı (7) gallons of water.

ɣainst black plant lice on cherry, plum, peach, grape, chrysɛmum and other plants, at the rate of one (1) ounce in (5) gallons of water.

ɣainst leaf-hoppers on roses, apples or grape, at the rate of (1) ounce in five (5) gallons of water.

ɣainst crawling larvæ of oyster-shell and San Jose Scales ıgainst larvæ of armored scales generally, at the rate of one ounce in five (5) gallons of water.

ıe material acts rather slowly sometimes, and at least 24 s should be allowed to elapse before the plants are examined ɛtermine the effects of any application made.

l applications should be made in a fine spray, with as much : as possible and should cover thoroughly. It should be mbered that this is a *contact* poison and cannot be effective ıs it actually touches the insects. Always mix with a rather l quantity of water first, and see that the material is very stirred in, so as to secure uniformity of strength.

, at the strength used the material is completely effective, ı weaker solution at the next opportunity. If the mixture ɔeen 1 ounce to 5 gallons, try it 1 ounce to 6 gallons, and so ntil the weakest effective mixture is reached.

, on the contrary the mixture is not effective at the strength , spray a second time, increasing the strength of the mix- until a satisfactory result is obtained.

all cases make careful and detailed notes of just what aptions were made and what the results were. No useful will be gained by the experiment unless all the factors mak- or success or failure are fully known."

iss Sadie E. McDonald reports for her brother, from ɛettstown, as follows:—"Shortly after setting out 3,000 ıge plants my brother was taken ill and ordered by the Doc- o seek a different climate and though his plants were culti- l nothing was said about spraying. I happened to walk ıgh the field on August 28th or 29th and was simply dis- ed to see the plants covered with lice and large green worms: were almost all eaten. I tried to get help to spray, but it ıed as if all were too busy to help me out. I made up my l to do it myself, but could not manage the spraying appa- s. So the only way I knew was to use my old friend the

garden sprinkling can. Using 1 ounce of Nico-Sul in 5 gallons of water, I sprinkled each plant carefully until I had about 2,500 done, and concluded to let the others stand to note the difference. It really seemed like wasting time on such badly eaten plants. I did not visit the field again for several days and then I could hardly believe my eyes. There were no lice left and very few worms and the few that were left had very little life. This cabbage grew large and solid so that I feel safe in saying there was no finer in North Jersey. No fairy wand could act more quickly nor do more than Nico-Sul did to worms and lice. As for those that I did not treat, they were sad indeed to behold and we had nothing but a few soft heads to feed to stock.* * * *I gave a little to a neighbor for a small amount of plants, and, like myself, he had only praise for its results."

Mr. Herbert W. Moore, Tottenville, N. Y., reports more briefly:—"I diluted according to directions and sprayed it on all sorts of garden vegetables, grape vines and flowers to destroy plant lice. It was very effective regardless of dry or wet condition of plants killing all of the lice which it touched. I also tried it on the green cabbage worms but without effect. The plants were unharmed."

I have elsewhere reported finding a plantation of young pines set out on the Newark water-shed, badly infested by lice of the *Chermes* species. Injury was so obvious and the danger to the plants so great that I suggested to Mr. Hermann Rosentretter, who is in charge of this water-shed the desirability of spraying with a combination of whale oil soap, 1 pound in 8 gallons of water, plus an ounce of Nico-Sul, which I sent him. He reported under date of November 16th "that we used the 'Nico-Sul' you so kindly sent me, in a solution with whale oil soap, as you directed, with very good success. We have sprayed the pines three times; the last application was made about a month ago as I found two or three plants to be still slightly inhabited by the louse. The young pines look very thrifty and have made a good growth during the year."

It was part of my original plan to use this Nico-Sul against leaf hoppers on apple and grape on my own grounds; but my trip to Europe in August made this impossible and it remains as something yet to be accomplished.

Quite a number of other insecticide preparations were received and some of them were tried; but results were not sufficiently definite to be published. So, a great many notes of successes and failures obtained from farmers and fruit-growers

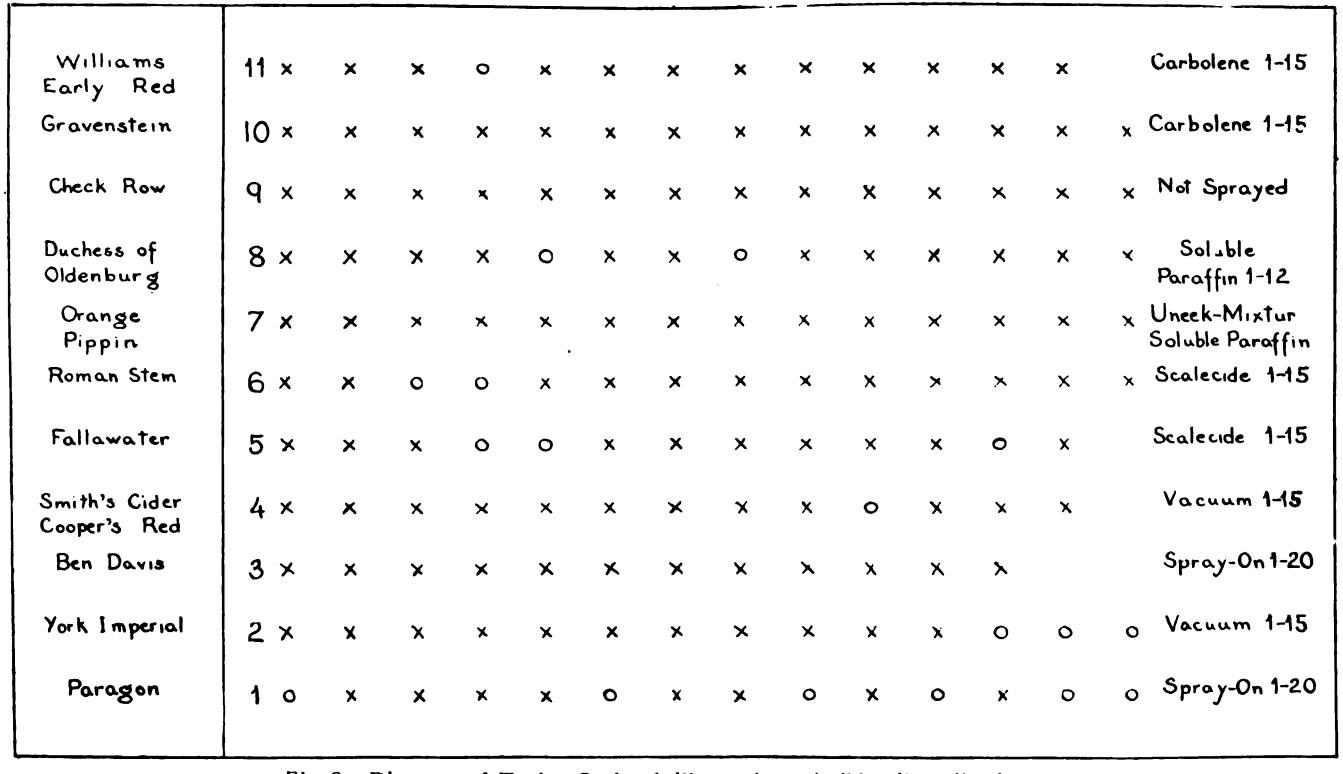

Williams Early Red
11 x x x o x x x x x x x x x
Carbolene 1-15
Gravenstein
10 x x x x x x x x x x x x x x
Carbolene 1-15
Check Row
9 x x x x x x x x x x x x x x
Not Sprayed
Duchess of Oldenburg
8 x x x x o x x o x x x x x x
Soluble Paraffin 1-12
Orange Pippin
7 x x x x x x x x x x x x x x
Uneek-Mixtur Soluble Paraffin
Roman Stem
6 x x o o x x x x x x x x x x
Scalecide 1-15
Fallawater
5 x x x o o x x x x x x o x
Scalecide 1-15
Smith's Cider Cooper's Red
4 x x x x x x x x x o x x x
Vacuum 1-15
Ben Davis
3 x x x x x x x x x x x x
Spray-On 1-20
York Imperial
2 x x x x x x x x x x x o o o
Vacuum 1-15
Paragon
1 o x x x x o x x o x o x o o
Spray-On 1-20

Fig. 8.—Diagram of Taylor Orchard, illustrating miscible oil applications.

ot be included because all the factors making for success
ıilure were not known.
ılphur mixtures in great variety are now being produced;
heir range comes more properly in the department of the
culturist at present.
› a great variety of oil preparations have come into being
will need field work to determine their proper range of
tiveness.

EXPERIMENTS WITH SOLUBLE OILS.

is a practical impossibility to make a test of all the soluble
now on the market, without a very large orchard of scaly
which can be used experimentally without regard to con-
ences. Nothing of this kind is available to me in New
ey, but occasionally an experiment on a small scale becomes
ible as when Mr. Howard G. Taylor, of Riverton, gave us
ıission to use 11 rows of his father scaly apple orchard
out regard to consequences.
ıe apple trees are large, have borne many years and have
more or less scaly for a number of years past. They are
er dense and have not been thoroughly trimmed out for a
time, so there is a large number of twigs and branches,
ering a thorough treatment difficult. It is like dozens of
r fairly good orchards throughout the State and therefore
esults gained may be considered generally applicable.
ıe materials in hand were Vacuum Oil, made by the Vacuum
Co., "Carbolene" and "Scalecide," made by the B. G. Pratt
"U-neek mixture" and "Spray-on Scale-off" made by the
hattan Oil Co., and Soluble Paraffin, made locally, by Mr.
R. Parry, of Riverton. This is a miscible oil, approximat-
he formula given in the report for 1907, but modified some-
by Mr. Parry to secure the best results from the materials
by him.
r. Dickerson was intrusted with the general direction and
rvision of the work and Mr. Taylor supplied the outfit and
r. The outfit consisted of a monarch pump with two out-
one spray rod with a vermorel from a tower, and one spray
with a single "Friend" used from the ground. The effort
to maintain a constant pressure of about 80 pounds and that
pretty closely held to.
he diagram, fig. 8, shows the rows, the varieties and
materials used on each. The X indicates a tree, the O
ace where a tree had been. A full row had 14 trees, but in

some rows the 13th tree had been omitted. The 9th row was omitted from the experiment because the trees were too large to be satisfactorily covered with the outfit.

All the fall sprayings were made with the wind blowing lengthwise of the rows from the numbered end, and from each side, so that rather more than two-thirds of each tree was thoroughly and the remainder poorly covered. The spraying from the opposite end was not made until spring, because no favorable fall wind was obtained.

November 23, 1909. Sprayed rows 1 and 3, with the "Spray-on Scale-off." The material was applied at the rate of 1 to 20. in accordance with the directions of Mr. Hutchinson of the Oil Company, who personally attended to the mixing and watched the application of his material. It combined well and sprayed well, and left an obvious oily film on the surface. It began to rain lightly soon after these rows had been sprayed and the work was abandoned for the day. An hour after the application the trees were examined, and it was noted that the droplets of water coming down gently, were shed by the oily surface. This material has a considerable percentage of wool-grease in combination and is materially different in character from the other miscible oils on the market.

November 29, 1910. Rows 2 and 4 were sprayed with *Vacuum oil,* 1 to 15. The oil was diluted with a little more than its own bulk of water first, and was then poured into the filled barrel. The mixture was good, only the slightest trace of rosin or tarry lumps forming in the process. Some complaints of trouble of this character were received during the previous season; but the sample here used could not be justly criticized on this point.

Applications were made as in the previous occasion and with the wind from the same quarter.

The *"U-neek"* mixture is a combination of wool-grease, petroleum, lime and sulphur in paste form. Mr. Hutchinson who was again on the ground mixed up 15 pounds of this paste with water into a thin cream and then added water enough to make 45 spray gallons—about 3 gallons of water to 1 pound of mixture. There was only a little sediment on straining and it sprayed satisfactorily. Only 7 trees in row No. 7 could be satisfactorily covered with the amount of mixture available.

Soluble paraffin at the rate of 1 to 12 was used on the second half of row 7, and on all of row 8. The dilution was a suggestion by Mr. Parry, and the mixing was done as with the Vacuum

oil. It combined very readily and formed a beautifully even, white spray-mixture.

November 30, 1910. Rows 5 and 6 were sprayed with Scalecide, 1 to 15, and rows 10 and 11, were sprayed with Carbolene, 1-15. In each case the mixture was made as with the miscible oils previously used, and the emulsion was as perfect and as satisfactorily applied.

The trees previously sprayed were also examined on this day. "Vacuum oil" and "Soluble paraffin" had both left an oily deposit on the surface, somewhat heavier in the case of the latter, which may possibly be explained by the fact that "Vacuum oil" was first used and was subjected to a drying wind which had ceased when the "Soluble paraffin" was put on.

The "U-neek" mixture was not very conspicuous and seemed deposited in minute, irregular streaks and not at all uniform. Traces of the wool grease were noted on the smaller branches.

The "Spray-on" had given a uniformly dark appearance to the surfaces on which it had been applied.

The balance of the orchard was sprayed by Mr. Taylor during the early days of December with the same wind and in the same general way, but not as part of the experimental work. "Spray-on" was used on 4 additional trees to give it another chance, but it did not mix so well in Mr. Taylor's hands, and left a decided oily surface film. The other oils were used so far as they each went until the work was completed, and Mr. Taylor reports that "Scalecide and Parry's Soluble Paraffin oil gave the neatest mixtures."

The spraying from the opposite end of the rows was not done until March 24th and March 28th, but the materials and methods of application were the same except as follows.

No more "U-neek" mixture was in hand, so the trees previously treated with that were treated the second time with "Spray-on." The trees treated with the Parry oil were sprayed the second time by Mr. Parry himself, and he got into trouble with his nozzles. He managed to use three barrels of mixture where one had been used before, and the trees were, in consequence, literally soaked.

April 13, 1910, Mr. Dickerson looked over the experiment rows and to all appearance all the materials had done good work. "Scale-on" had left a distinctly oily or greasy surface coating on the bark, that seemed to make it an undesirable fixing place for larval scales.

The trees treated with the "Soluble Paraffin" were not only decidedly oily, but had been materially retarded. There seemed

to be no definite injury, but without any doubt the trees were far behind their neighbors in development.

May 11th, the "Soluble Paraffin" trees had caught up with their neighbors and no appearance of real injury due to this material was noted. By this time some of the extraordinary effects of the fungicide applications made in this year of grace 1910, had begun to make their appearance and we could only determine that the trees in our experiment rows were no worse than any others so far as fruit and foliage were concerned. Nor were they in any wise better.

July 18th, the scale had begun to breed and it was possible to note effects. I quote Mr. Dickerson on that point: "The mixtures all appear to have been effective, save "Spray-on" and on the trees where the latter mixture was used there is too much live scale. I do not mean that it did not do any good, for it killed the majority of the insects I believe; but not enough, judging from the condition of the insects at the present time, to be thoroughly effective. It evidently needs to be used at greater strength."

Defects in application also became evident at this time and an occasional badly infested twig or branch with equally infested fruit showed where sprayings had not met.

August 30, 1910, matters were as before only more so. The "Spray-on" rows were now badly infested, and an occasional branch in the Vacuum rows was also in bad shape; but that, Mr. Dickerson is inclined to charge to defective work. All the other rows are reported in fair condition so far as scale is concerned.

October 28th, was the date of the last inspection and Mr. Dickerson's report is practically a duplication of the previous one. Some infested fruit was found in all rows where any fruit remained and in others there was tip infestation to a small extent. The "Soluble Paraffin" had done perhaps a little the best work; but that had been applied at greater strength than any other and much more abundantly as already described. The "Spray-on" had the greatest dilution and rather the worst infested rows to deal with.

Mr. Dickerson also suggests that the trees are rather too large and too thick to be properly treated with a hand pump. He thinks a power pump giving greater force and better distribution of material would have produced more satisfactory results.

As an experiment under normal orchard conditions with an average outfit the outcome is instructive.

In this connection it may be well to say that it seems demon-
-able that spraying with miscible oils should not be done when
e temperature is near the freezing point, especially if the
ather is clear and dry. Under such circumstances the oils
not do their best work, the freezing of the watery mixture
ds to destroy the combination and, if any injury at all is pos-
le to the trees, it will occur under such conditions. At any
nperature above 40° Fahr., the applications can be safely
ade.

ORT ON THE MOSQUITO WORK FOR 1910.

Report on the Mosquito Work for 1910.

By JOHN B. SMITH, Sc.D.

he legislature that met in January 1909 made no provision the continuation of the mosquito work, and therefore work ssarily ceased October 31st, 1909. The executive officer inued to serve as such without pay so far as the circumces of the case demanded. Mr. H. H. Brehme was given finite leave without pay, and Mr. John A. Grossbeck was sferred for a time to the Experiment Station service and given leave of absence, while Miss Augusta E. Meske was transferred to another service permanently, altho she coned to do what clerical work was essential.

he Legislature that met in January 1910 provided $10,000 a continuance of the work during the fiscal year 1909-10, no part of that sum became available until late in May 1910, vhich time the staff was restored except that Miss Meske, o she continued to do the clerical work required, drew no therefor.

he financial statement is as follows:—

l appropriation				$10,000.00
Drained area.	Acreage.	Feet of Ditching.	Cost.	
ield Tp.	4,000	312,000	$5,949.00	
le Marsh Cr.	650	38,000	900.00	
	4,650	350,000	$6,849.00	
beth, additional work			200.00	
acus, additional work		(5,000 ft.)	200.00	
nne			150.00	
squan, cleaning ditches			15.00	
an, " "			35.00	
rd, " "			22.50	
nses of administration			2,528.50	
				$10,000.00

The expenses of administration include the salaries of the executive officer and two assistants, all the advertising and traveling expenses, as well as the cost of apparatus, supplies and ordinary office expenses.

The service sustained a serious loss by the resignation of Mr. John A. Grossbeck who accepted a position in the American Museum of Natural History, and his position is now filled by Mr. Walter S. Abbott, of New Hampshire.

The circumstances just recorded made it impossible to make great progress in the area drained, which is now as follows:—

	Acres.	Feet of Ditching.
Up to 1907, as reported	15,851	2,215,524
In 1908 as reported	6,669	888,650
In 1909 as reported	2,672	360,800
In 1910 as above	4,650	350,000
Total	29,842	3,814,974

For a variety of reasons it was deemed advisable to discontinue the work along the Barnegat Bay, and to make a start among the extensive marsh areas along Delaware Bay whose mosquito output affected a large permanent population. It was also considered desirable to make the residents of that section of the State directly acquainted with the character of the work done and with the manner in which the check upon mosquito breeding was to be accomplished.

The seasonal conditions were peculiar; there was a reasonably wet spring which favored early marsh development, and wherever no drainage work had been done or where blockages had been allowed to occur, terrific broods made their appearance early in the season. Every defect in the drainage scheme became apparent, and few of the marshes stood the test perfectly. But as a matter of fact nearly all of our more recent work *did* stand the test, and while some of our earlier areas must be improved in the light of recent experience, we may reasonably hope that our future work will stand any test that can be imposed on it. As the season advanced, the differences between the drained and undrained areas stood out ever more strikingly, and the influence of the work done extended for long distances inland.

After the early wet weather came a period of drought, followed by a terrific heat, occasionally broken by violent storms and heavy local rains. But most of the summer was dry and for weeks no rain fell in some localities. Theoretically this should have prevented mosquito breedings; but as a matter of

fact, the reverse was the case. Beginning in July, the cities were invaded by swarms of the ordinary house mosquito, *Culex pipiens*, worse than anything for years past. In late summer the species of *Anopheles* joined the invaders, and there were more cases of malaria in many parts of New Jersey than within many recent years.

The explanation is simple enough. Wherever there is a sewer system, the catch-basins send out swarms upon swarms of *C. pipiens* without check. This is no mere guess or belief but an observed fact. In town after town Mr. Brehme demonstrated to the health officers that egg-masses, larvæ and pupæ crowded the water in these basins so that it seemed almost a mystery how they could find room to exist.

And as the summer advanced, the ponds and streams began to dry up and to break up into pools. Instead of a running brook there came into being a sluggish ditch or a series of disconnected pools, and in these were wrigglers by the millions. Shallow ponds invaded by vegetation along the edges were drawn down so that *Anopheles* could develop safely, and in one instance, in one place theretofore safe, 10 *Anopheles* larvæ were taken up in a single dip with an ordinary tumbler.

It was at first believed in those communities within reach of the salt marsh species that our work had failed, and that there was a recurrence of the old conditions; but in every case where specimens were secured, it was found that the local forms were in fault. In every case, even where a mosquito service existed, the local authorities were caught napping, and one or more broods escaped before adequate measures of control were adopted.

One good thing developed out of this condition: it became obvious that the remaining problem is a local one, to be dealt with by the communities of a neighborhood, and it brought into being the North Jersey Mosquito Extermination Association, consisting of representatives from Hudson, Essex, Union and Bergen Counties, banded together for the elimination of local breeding places and to prevent the recurrence of conditions existing during the summer of 1910. Specific reference to some of the conditions will be hereinafter made.

Practically nothing was done in the trial of materials for destroying larvæ or adults. One larvicide is hereinafter mentioned and some additional experiments were made with "Japsticks," which added little to our previous knowledge.

AZOLLA INVESTIGATIONS.

In the report for 1909, reference was made to the species of *Azolla* and *Lemna* and their probable function or usefulness in controlling or preventing mosquito development. There was no pretence that the mere growth of the *Azolla* made the water unfit for mosquito habitation, but that the plants multiplied with such rapidity that they formed a mechanical covering that prevented egg-laying by female mosquitoes in the first place, and the development of the wrigglers in the second. Theoretically the idea was an excellent one and the facts seemed to support it. Such publications as came to hand made very definite statements of favorable results, and fac-similes of a letter from the German Minister for the Colonies, added weight to the claims made.

After the publication of the previous report I received from the "Botanische Staatsinstitute at Hamburg," through the agency of Dr. Meyer, a sending of the *Azolla* species cultivated at that place, and a similar sending was made to Dr. Fairchild at Washington. Both of these sendings arrived in bad condition and the plants were dead. Dr. Meyer's report to his chief indicated that the German officials were by no means a unit or enthusiastic in their belief as to the value of the plant, and definite information seemed hard to obtain.

Through the courtesy of Mr. P. Ouwerkerk of Hoboken, one of our nurserymen representing the Association Flora, of Boskoop, Holland, I secured several jars and bottles of the species of *Lemna* and *Azolla* taken directly from the ditches in that country, and these I personally carried to the Bronx Park and turned over to the care of Dr. Murrill then acting director.

Unfortunately the *Azolla* of this sending also failed to survive, and that left for propagation only the material brought from Kew by Dr. Stevens, and from Bergen, N. J., by Dr. Nash.

During the winter of 1909-10 I sought in vain to get definite information concerning the habits and peculiarities of these plants and I began the season of 1910 without real knowledge as to the conditions under which the plants would best thrive. Lack of available funds prevented an early start, and not until May 20th could I send Mr. Brehme to Bronx Park for a supply of material to be put out. Six boxes of plants were obtained—three of them *A. caroliniana* from the Kew material, one *A. caroliniana* from New Jersey and not the same species, and two boxes of *Lemna* including three species.

Four ponds were selected by Mr. Brehme as complying with the requirements which I supposed the plants made. One of

hese was within the limits of the City of Newark, one along the Pennsylvania R. R., near the line between Newark and Elizabeth, one in Elizabeth on an abandoned Race track, and one on Great Island where the plants would not be disturbed.

The planted areas were periodically examined by Mr. Brehme nd from the beginning and until early July, the New Jersey pecies did well: the species from Kew increased very slowly ntil June and then, after being separated and transplanted to ther ponds, it did fairly well until early July. Then came the eriod of terrific heat and drought, and by early August there as nothing left alive. As late as September 13th, Mr. Brehme earched closely where the plants had done best and found othing. The plants in the Great Island pond were almost certainly killed by an admixture of salt water which came in on a eavy wind and tide, so as to make the water perceptibly brackish.

All these experiences pointed in one direction—the absolute ecessity for a personal investigation of the subject on the ground self and, since none of the money appropriated by the State ould be used for that purpose, it was necessary for me to go at ny own expense, under leave of absence secured from the director in charge.

INVESTIGATIONS IN GERMANY.

I reached Hamburg, early in September and at once put myself in communication with the "Botanisches Staats-Institut," onnected with the Botanical Garden. There I ascertained that *zolla* was nowhere native in Germany and that they had not ucceeded in keeping it alive, out-doors, over winter. There as no difficulty however in wintering it under glass and in getng it to grow readily in summer, in their ponds. All the maerial obtained by Dr. Bartmann in his experimental work came om these gardens and so far as they were aware, no systematic ttempt had been made to develop races. In their experience en a small percentage of salt suffices to interfere with the owth of the plants, and no experiments had been made with e view of propagating them by means of spores.

A very distinct drawback to the propagation of the plant is its ilure to grow well early in the season, or until the water has come decidedly warm. Mosquito larvæ in general develop at ast one brood before the *Azolla* is well under way, and it rarely rms a complete covering in a shaded area or until after midmmer. After midsummer, in favorable areas, the plant forms

a perfect mat on the surface of the water, killing off everything else and preventing the breeding of all surface feeders. It does not injure fish and it floats readily on the surface, so that a heavy wind will drive it to one side or end of a pond. The official experiments were not made by this Institute, but by another branch of the government service, and the only function of the Institute was to furnish supplies of plants as needed. They have developed a method of preparing these plants for transportation now, that carries them safely on journeys to the tropical colonies where experiments are still under way.

Prof. Dr. Voight of the Institute, and Inspector Wittmeyer of the Garden, were good enough to assure me that I could obtain from the Institute and Garden all the material needed for carrying on further experiments in New Jersey, should I decide that such were desirable. To these gentlemen as well as to Dr Charles Brick of the "Station für Pflanzenschutz" I owe thanks for the courtesy that started me on my investigation and for the information that served to guide me in my subsequent studies.

The actual experimental work with the *Azolla* is in charge of the "Institut für Schiffs- and Tropenkrankheiten," and at the Institution Professor Dr. Fülleborn, very courteously gave me access to all their records and such information as he personally had, concerning the subject. He looked out for me all the literature indicated in their very complete reference cards, so that I had the opportunity to post myself fully, not only on all that has been published concerning the work, but on those points that accumulate in all laboratories and are never published because they represent steps and failures, rather than final conclusions. These, under the circumstances, were of quite as much importance to me as the published conclusions, since they saved me a great deal of work and inquiry that might otherwise have been necessary.

Experiments were made in the laboratory and in the field with fresh water and water containing varying percentages of salt. The results of the latter demonstrated that even a slight percentage of salt was fatal to the plants, and that a mere trace prevented effective development. Such as they were, these experiments reported upon by Dr. Mülhens, and made near Wilhelmshafen, are conclusive. His language is definite and unqualified: "In brackigem Wasser gedeiht die *Azolla* nicht"—In brackish water *Azolla* does not thrive. The territories along the North Sea, near Cuxhafen, Wilhelmshafen, etc., are very unlike our salt marsh costal region, and are rather turf moors, not so unlike the Netherlands in origin and composition, so the results

ained there cannot in all respects be regarded as conclusive New Jersey; but we are justified in the conclusion that so far our along-shore problem is concerned, *Azolla* can be elimi-ed as a factor.

At three different points *Azolla* was planted out, beginning ard the end of May; but not until after the middle of June any plants begin to multiply, and then it required a period ix weeks to secure a tolerably complete covering to the rather ll ponds—30, 50 and 100 square meters. Even then the ering did not close the edges where reeds grew and, while in body of the pond no *Anopheles* larvæ could be found, e was no difficulty in finding them in numbers along the es. A cold spell in August resulted in killing off a large entage of the plants, making the cover incomplete and nitting the development of a new brood of larvæ. A warm l in September improved conditions once more, but as the l result of the work and of the observations lasting through-the season, the following conclusion was reached: "Meiner icht nach kommen Azollenanpflanzungen zum Zweck der hinderung der Mückenlarvenentwicklung hier in unseren enden kaum in Betracht"—In my opinion plantings of *Azolla* revent mosquito-breeding in our locality need hardly be con-red!

was determined definitely that a complete *Azolla* covering prevent mosquito development, indoors and out; but that so y factors tended to prevent or to break into this covering practically the plant was useless. It left open, however, the estion that under more favorable conditions, in a warmer ate, the plant might have a much greater range of usefulness might form an important check.

unlight and air, plenty of warmth but not excessive heat, and nanent water supply are essentials to vigorous *Azolla* growth that combination does not exist in that section of North many where the experiments were carried on.

he outcome of the various laboratory experiments was, on whole confirmatory of the field results, and indicated that rever the plant would thrive, it would form a most important or in lessening the mosquito supply.

HOLLAND INVESTIGATIONS.

It will be noted that, while I had secured in Hamburg and vicinity a great deal of information concerning *Azolla* and the experiments made with it, nothing was known concerning the conditions under which the plant occurred naturally. Nowhere in that section of North Germany is *Azolla* a native, and nowhere does it survive the winter out-doors. No additional information could be secured at Bremen, and my next trip was to Amsterdam where I found communications from Dr. Ritzema-Bos, Director of the Phytopathological Laboratory at Wageningen, and Mr. P. Ouwerkerk, of Hoboken, then also visiting Holland.

The outcome of the arrangements made, was a visit to Boskoop in company with Dr. Quanjie, representing the Dutch Government service, Mr. C. Ph. Moerlands, a teacher at the Agricultural School at Boskoop and Mr. Ouwerkerk, who had made all arrangements for and acted as host to the party.

Boskoop is a nursery centre with a large export trade to the United States, and I had visited it previously. It is in one of the "polders" or reclaimed areas, lower than the sea-level, cut up by canals and ditches in every direction, the surface water kept down by pumps, largely worked by wind-mills. Almost every canal and ditch was covered with *Lemna* or *Azolla* or both, sometimes forming a perfect carpet, sometimes broken and fragmentary. The latter condition it was said, was largely due to the fact that the plants had been raked off and piled to be composted, a practice which occurred two or three times yearly, whenever the surface mat became very thick. Here the *Azolla* lives and thrives and appears year after year, sometimes in greater, sometimes in smaller quantity. The species is believed to be *A. filiculoides*, altho no one really knows very much about it. As a matter of fact two species occur here, one very much larger than the other, with prominent spore capsules where the smaller species had none. Here, and at Hazerswouda, on the nursery of K. Wezelenburg & Son I made my first acquaintance with *Azolla* under natural conditions.

Afterward I covered the territory from Amsterdam east to Naarden and South to Oudenbosch. I stopped over at Haarlem, Leiden and Rotterdam, and made excursions into the vicinity, sometimes alone, sometimes with others from whom I hoped to gain information, and in brief I learned as follows concerning these plants.

3.—Ditch through nursery district at Boskoop, Holland, completely covered by an *Azolla* carpet. Original photograph.

Azolla is not originally a native of Holland, but whence it did ıme seems to be a little uncertain. It was intentionally intro-ıced at Leiden by the Hortulanus of the Botanic Garden there, ɔurished and escaped into the polders. Another lot was intro-ıced somehow into another section and the two forms—perhaps vo species—soon drove out the native Lemnas in certain sec-ɔns. Of recent years the *Azolla* seems to be rather declining ıd the Lemnas are regaining their old ascendency; but that is ɔt uniform. The important point is that the distribution of *zolla* in Holland seems to be co-incident with the occurrence ; the peat or turf "polders." Between Haarlem and Leiden, ɛar Hillecomb and Boskoop, is the centre of the *Azolla* region, ıd that is all peat bottom. South of Rotterdam the *Azolla* ɛters out rapidly, and on the higher land at Oudenbosch there none in the ditches, altho *Lemna* occurs in greater or less ɔundance. East of Amsterdam the same condition occurs, and hile the land is low enough at Naarden, the soil is more sandy ıd *Lemna* alone is found in the pools and ditches. In Belgium failed altogether to find *Azolla;* but I had neither the time nor ıe funds to make any very extensive search in that country. he ditches and canals in which the plants occur are all from vo to three or more feet in depth, and are stagnant in the sense ıat there is no outlet. There is of course a very slow flow to ıe point from which the water is pumped into the natural water-ɔurse or higher level canal. I did not at any point find A*zolla* ı shallow pools, nor did I find it in reedy or grassy shallows. did find it close to the sloping banks of broad and deep canals ıch as those in the City of Leiden, altho in such cases it never ɔrmed a carpet or mat. Smaller ditches in the open "polders" ften had the surface completely matted for hundreds of feet ıd no doubt mosquito breeding in ditches so covered, is a phys-al impossibility. Several species of fish occur in these ditches ıd even where there is no *Azolla* or *Lemna* there is practically ɔ mosquito breeding. In a heavy wind the plant carpet on the tches shifts and may be piled up several inches thick at one end, hile the other end is free. With the approach of cold weather e color of the common species changes from green to purplish d, and the *Azolla*-covered area is then easily distinguished from e *Lemna*-covered surfaces. The vegetative surface plants are led by the frosts, and growth is not resumed until well along in ɔring. *Lemna* is far ahead of *Azolla* and has formed a cover-g before *Azolla* gets a good start. By mid-July *Azolla* has rced out and replaced the *Lemna,* and has formed a coating ıich is maintained with more or less completeness for the bal-

ance of the season. It will stand being almost completely rake off twice in the season and will form another complete coating in three or four weeks thereafter, unless the raking off is done too late in the season and early frosts intervene.

Apparently the spores of the plants sink to the bottom and winter in the mud. Ice forms throughout Holland on the ditches, and almost every winter there is an ice coating on the canals as well. The temperature rarely gets as low as in the average New Jersey winter, and only on rare occasions do any of the ditches freeze to the bottom or is bottom or ground ice formed. Whenever this has happened, *Azolla* has been largely killed out and, in general, a severe winter is always followed by a summer in which *Azolla* is scarce.

The above statements are the results of about three weeks personal investigation and of the numerous questionings made. The persons questioned were scientific men in part and, more largely, practical gardeners and nurserymen who have seen and observed these plants for years and who have had a direct interest in noting whether or not they were abundant and the conditions that made for their abundance or scarcity.

It will be noted that *Azolla,* while plentiful enough locally, is by no means widely distributed, and that it requires very definite conditions for its best development. It is not susceptible of universal propagation; but there seems to be no reason why it should not thrive in some of our New Jersey ponds and lakes, particularly in the southern parts of the State. It is a beautiful plant and, so far as I have been able to ascertain, is in no way a detriment to the waters in which it occurs.

Altho I cannot at present see any hope of making any extensive practical use of the plant, I have considered myself justified in attempting its introduction into the country, and in this I have had the co-operation of Dr. N. L. Britton, Director of the Botanical Garden at Bronx Park, N. Y., and of Messrs. Ouwerkerk and Wezelenburg of Boskoop, Holland.

I have already mentioned the fact that Mr. Ouwerkerk, of Hoboken, was present in Boskoop during my visit there. At my request he carried with him on his return a small pail of the plants and these were turned over to Mr. Brehme for transmission to the Bronx Park, where they arrived in excellent condition.

Mr. Wezelenburg was good enough to gather for me a pail of the plants on his place at Hazerswoude, and to send it to me at Rotterdam, the day before I left for New York. This lot, car-

Fig. 1.—A canal near Boskoop, Holland, completely covered with *Azolla;* only a few bits of open water in foreground. Original photograph.

Fig. 2.—A broad ditch through a Dutch "Polder"; completely covered by an *Azolla* carpet. Original photograph.

ried in my stateroom, also reached New York in fair condition, was received by Mr. Brehme and transmitted to Bronx Park.

At present writing the colonies are in the greenhouses of the Bronx and it is hoped will be in good condition for further experiments in the Spring of 1911. Meanwhile interest has been excited in Holland, and I expect to be able to secure the plants in the spore stage some time later in the season.

I wish again to say that while the results of the investigation are disappointing in that the plants are not of wide application in the matter of mosquito control, there is more than a possibility that they will be of some importance locally in New Jersey and may be of much greater value in some other places further south, where natural conditions may favor them more.

REPORTS ON LOCAL CONDITIONS.

HUDSON COUNTY.

Hudson County is almost unique in the State in having an organized County board of health. This board appointed Mr. Wm. Delaney of Jersey City at a substantial salary to look after the mosquito breeding areas of the county, and the appointment fully justified itself. During the entire summer Mr. Delaney kept the total county area under observation and, so far as his authority extended, secured an abatement of breeding areas. He had about 2,000 feet of ditching done at necessary points at his own expense, and secured an enormous amount of work from others.

One important feature was a systematic survey of the conditions along the rights of way of the various railroads within the county, and a conference with the officials empowered to make improvements therein. The Pennsylvania, Central and Lehigh Valley Railroads, and the Public Service Corporation responded; and work costing nearly $30,000 was begun and in large part completed by these corporations. *Pipiens* breeding places were mostly affected, and the improvements consisted mostly in filling stagnant swamp areas or low places along the rights of way. It was encouraging to note the readiness with which the officials in charge appreciated the importance of the work urged by Mr. Delaney, and their prompt response to his suggestions. The local authorities within the county were informed of breeding places within their jurisdiction, and assistance was given in

every way whenever asked for or whenever there was reason to believe that it would be welcomed. Taking Hudson County as a whole, conditions are much better than they were ever before and Mr. Delaney deserves a large proportion of the credit therefor. His official connection with the Jersey City board of health ceased in 1909.

SECAUCUS.

In the early spring this area was looked over several times and on the whole, it remained in good condition throughout the season. A great deal of work has been done in this territory by the railroads, and the new line of the Pennsylvania railroad especially, has affected drainage conditions somewhat. The water therefore, does not get off the meadow quite fast enough, and in a combination of high tides and rainy weather conditions may favor the emergence of a brood. This happened early in the season when some of the ditches were blocked, and it was thought believed that removing these blocks would be sufficient to mend matters. But even after the blocks were removed by the Jersey City authorities the drainage proved too slow, and 5,000 feet additional were added after midsummer at an expense of $200.00 to facilitate the removal of the surface water. It is believed that unless further, extensive interference takes place, the meadow will remain safe from mosquito breeding under all conditions. Whatever other work was done on this meadow was either by Mr. Delaney along the cat-tail area, or by Mr. Sprouls in cleaning the ditches.

JERSEY CITY.

The work during the summer of 1910 was in charge of Mr. Jos. A. Sprouls, appointed as Mr. Delaney's successor by the City Board of Health. Mr. Sprouls was unfamiliar with the work and with the habits of the insects, but was anxious to learn and willing to do whatever was possible. He is, however, a business man, actively engaged in his work and was compelled to rely very largely upon the reports of the men assigned to him, who were themselves unfamiliar with the work expected from them. In consequence the supervision of the marsh ditches was neither so prompt nor so thorough as in the previous year, and while no very bad conditions developed, the work was not so well done as it should have been or as Mr. Sprouls was made to believe that it was done. The workmen simply soldiered on the job as much

as they dared, especially at points somewhat remote, which they had reason to believe would not be visited by Mr. Sprouls. A little breeding occurred on the meadow, but not enough to make a flight into the City, and on the whole very few salt-marsh mosquitoes occurred in Jersey City during the season.

For the house-mosquito there was quite a different record. As early as May 10th, Mr. Brehme found larvæ well grown in favorably situated pools, and notice was at once given to Mr. Sprouls. Oiling of pools and catch basins began next day, and was carried on more or less continuously throughout the season. But the men were inexperienced, did not always use good judgment in the work, and undoubtedly oiled many safe places while missing as many others that were genuine breeders. Besides there were only two men, the territory to be covered was large, and the number of catch basins nearly 3,000, aside from other breeding places always present in the outskirts of a large city. The general conditions already referred to were effective in Jersey City as in other municipalities, and there was a heavy infestation of *pipiens* throughout the town. They were rather more abundant in the outskirts however, because of the more numerous breeding places and because more water got into the catch basins from flushed streets, etc., rendering them less dangerous as breeders. Besides, so much oily and other material detrimental even to wriggler activities gets into catch basins in the heart of a city that they are not so virulent as breeders as those where the water is less filthy.

A great deal of work was done by Mr. Sprouls and his men and a great deal of good was accomplished. The conditions were against them and inexperience did the rest.

No State money was spent within the boundaries of Jersey City during the season.

BAYONNE.

In the report for 1908, attention was called to the fact that the City of Bayonne had provided $500 to clean up the mosquito breeding territory within its limits according to plans and suggestions furnished by the executive officer. It was also stated that the City elected to do its own work in its own way, and that neither the plans furnished nor the suggestions made were followed. Some benefits resulted, but the work was not properly done and the improvements that might have been obtained by a proper direction of some filling operations, were never secured.

The matter was again taken up in April, 1910, largely through Mr. Delaney's urgings, and an open meeting of the board of health was attended by me, at which the breeding conditions in the city were explained at length.

I explained the relation of the State to the work, and offered to meet the amount contributed by the city by an equal amount from the State funds, not to exceed $150, provided the board would undertake to keep the work in running order and protect the ditches when put in. The offer was accepted; but the $150 for the city was obtained from officials of the Standard Oil Company, on whose property some of the breeding places were situated. Under the general supervision of Mr. Delaney, advised however by Mr. Brehme of this office, $300 was spent in ditching that eliminated the worst of the breeding areas.

There is, however, one area so inclosed by streets and railroad embankments that no outlet for surface water is obtainable and this area must eventually be dealt with by filling. Dumping is already in progress, but proceeds slowly because, instead of first covering the surface, a high fill is made from the edge which, at the present rate of progress, will require several years to complete.

Oiling was the only remedy for this area and the Standard Oil officials supplied the oil free of charge, leaving the City authorities only the cost of application. Unfortunately, here again inexperienced men were in charge, and they did not recognize the importance of either prompt or thorough work. In consequence, altho they had notice in some cases, they permitted broods to escape before they were ready to treat, or they failed to reach all parts of a partly over-grown area and permitted the safe emergence of some of the advanced forms.

The outcome is that, while Bayonne is in much butter condition than ever before, and in a normal season will have very few mosquitoes compared with past years, there are yet some unsatisfactory areas to be dealt with, requiring the expenditure of about $300. As this is practically all a matter of the local breeders and not of salt marsh species, my office is an advisory one merely, and no more of the State money should be appropriated.

POINT-NO-POINT.

Conditions on that meadow were rather fully described in the report for 1909, and while a great deal of work was done on the area, it was mostly in the direction of making the

area already filled available, rather than the adding of new area of filling. During the year just past several streets have been graded and completed through the western, filled area; three spurs from the Pennsylvania Railroad have been run into it, an extensive lumber yard has been established, and other commercial enterprises have been started on the territory. Some filling has been added, but there is yet a considerable territory that remains in a thoroughly unsatisfactory condition.

Anticipating trouble, I asked Mr. Brehme to go on the meadow April 6, so as to be in a position to warn the Newark and Jersey City authorities, in case of necessity. Mr. Brehme reported the meadow covered with water from the recent storms and the water filled with larvæ recently hatched.

Two days later after continuous dry winds, most of this surface water had disappeared and with it the entire first brood of larvæ. The water remaining in those ditches that had been persistently oiled during the summer of 1909 contained very few wrigglers and, altogether the danger from the first brood of *cantator* was past.

April 20th, after another heavy rain the meadow was again found covered with water and some larvæ were present. These increased in number during the next few days and grew rather slowly. It was hoped that the meadow might again dry off, but it did not, and notice was given to Jersey City that oiling would be necessary. The work was done on May 5th and 6th by a gang sent out by Mr. Sprouls, and on May 10th, a renewed inspection showed that almost everything had been killed off. There were a few specimens on the meadow, but only a slight scattering and not enough to provide a flight into the cities. The second brood was thus fortunately disposed of. A few small pools with larvæ were found that had not been oiled; but these were all dry four days later.

May 25th, there was another brood on the meadow after another series of heavy rains; but that was mostly confined to areas that were dry when the oiling was done on May 5th. Mr. Sprouls was again notified, and again the oil brigade did excellent service.

June 18th, found another covering of water on the meadow, but at this time larvæ only in one section along the water pipe that had been under repair and where holes had been dug and left open. There were 60 or more of these, and all of them with a supply of wrigglers. Where the oil had been applied earlier, there were practically no larvæ. Mr. Sprouls was again notified, and on June 29th the meadow was entirely safe except

for a small area requiring about five gallons of oil. Mr. Dobbins, who was in charge of the Newark work was notified on this occasion, and on July 9th the meadow was found free from larvæ and adults.

August 13th, the meadow was almost completely dried out. Water was found only in the holes along the water pipe and all these were oil-covered from the application made a month before. The drought was now on, and no further inspections were made until September 3rd, at which date the meadow was again covered through a break in the water pipe. It was feared that this might favor the development of another brood, but on September 14th the break had been repaired, the remaining water was oil covered, and only the merest scattering of larvæ was noted.

October 4th, the meadow was still in good condition and only a few adult mosquitoes and a few pools with scattering larvæ were seen. As a whole this area gave very little trouble during the season, and added nothing to the supply of either Jersey City or Newark. One reason for the exemption late in the season was the very heavy application made early in May against the second brood. The experience of 1909 seemed to indicate that a heavy application of oil might produce much more lasting effects than was generally believed, and the experience of 1910 has confirmed this. Where a heavy coat of oil had been applied the film remained, and as the water evaporated, settled on and into the surface. When there was a subsequent flooding this surface scum seemed sufficient to form a film that was fatal to the young larvæ. This point will be more thoroughly tested out next season if possible.

NEWARK.

The City's experience was far from satisfactory during the season, chiefly because of neglect on the part of the men employed, during the early part of the season. The high tides of March all drained off in good shape, and on the first inspection, April 5th, Mr. Brehme reported matters in general good condition, with very few larvæ on the meadow. Some irresponsible filling work had blocked a section of the Hamburg Place meadow, and muskrat hunters had deliberately blocked another section. These places were pointed out to the men at work on the meadow.

The work was fairly well done here, but almost unaccountably the remainder of the meadow was not patrolled and when, early

May, a few *cantator* were noticed in the City, the man in
ırge professed to be ignorant of their source. It was easily
)ugh discovered on the Waverly section by Mr. Brehme, and
mmissioner Dobbins who was again in charge for the Board
Health, was duly notified. Unfortunately the Commissioner
ended upon the reports of his men that they had cleaned the
tion as needed, and not until May 21st when the lower part
the City was invaded by freshly hatched mosquitoes did he
down himself, with Mr. Brehme, who pointed out the source
the supply in the most convincing manner. There was abso-
ly no excuse except the laziness and incompetency of the
ı employed, for this infestation. Money enough was spent
lo the necessary work; but it simply was not done. Timely
ice was given by this office, but the requirements of the work
where in the State made it impossible to determine whether
warning had been heeded—nor is that the business of the
cutive officer.

une 13th, another brood of larvæ was noticed on the Waverly
ıdow by Mr. Brehme, and the person in charge of the work
ı notified of the fact and that prompt action was necessary.
ıe 22nd, Mr. Brehme again went over the meadow and found
ters worse than ever. Nothing had been done to kill off
brood at Waverly, and they were now nearly ready to trans-
n. A road had been built without regard to the drainage
)ss the Hamburg Place area, and altho this had required
ıy days, not one of the men who were supposed to be looking
r the meadow had seen or reported it or the brood of larvæ
promptly appeared. Again a lot of specimens were allowed
scape absolutely without excuse, and considerable work will
ıecessary to restore the safety of this area.

he beginning of the droughty conditions ended the trouble
this meadow and practically nothing more was done. On
inspection made September 21st, Mr. Brehme reported the
litions unsatisfactory, and later in the season presented a
ewhat elaborate report of what is necessary on this Newark
marsh area.

irst of all, none of the criticisms here made are intended
ıny way as a reflection upon Commissioner John W. Dob-
s. He has spent a great deal of his time and has done a
ıt deal of work in this matter absolutely without recompense,
did it depend upon his faithfulness only, there would be little
ble in Newark. But the Newark marsh is extensive and not
accessible except on foot. It means long tiresome tramps
ıot weather to keep it under proper supervision, and Mr.

Dobbins accepted the reports of his men as to conditions and as to the work they had done. One of these men is perfectly competent to act in the position to which he was appointed. He knows the meadow perfectly, knows the danger points, knows the insects in all their stages and knows exactly what should be done. But he evidently did not fancy the exertion required to do his work properly and by his untrue and misleading reports kept Mr. Dobbins in ignorance, until Mr. Brehme convinced him by taking him on the meadow himself. I do not even wish it to be understood that Mr. Dobbins did not go upon the meadow personally—he did: he visited time and again those places that he knew required watching, like the Ebling tract, and there practically nothing got out.

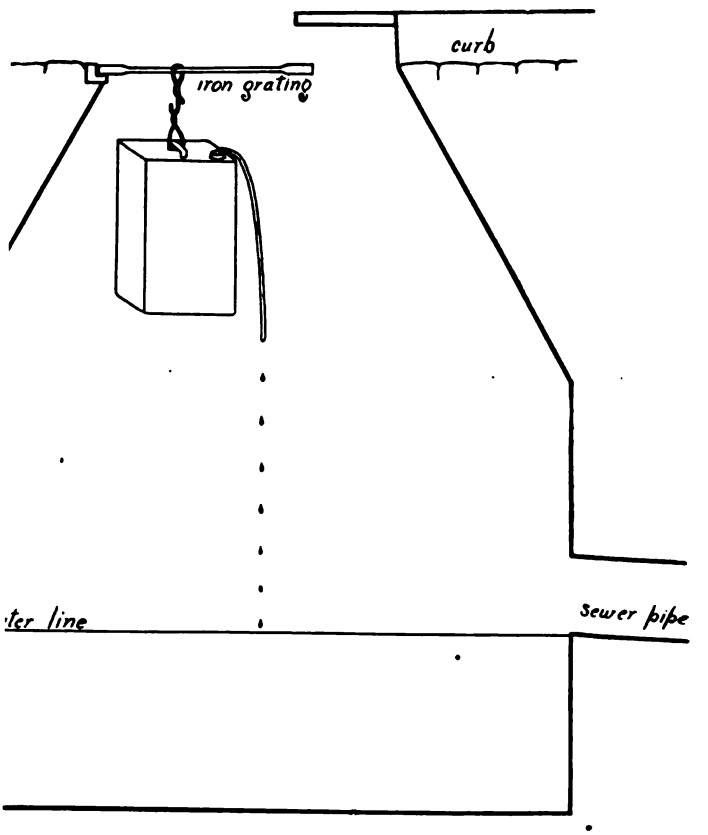
As the result of the observations made during the two or three years last past, and as the result of the change in conditions caused by the natural growth of a great city, a considerable change of and addition to the drainage scheme is needed, and it will require the expenditure of approximately $2,000 to drain the meadow so completely that no surface water can remain on any portion of it. A great many acres of land that used to breed mosquitoes have been redeemed and safely filled since the original drainage scheme was carried out; but a great many acres have also been so changed that what was originally quite sufficient, is no longer so, and more ditches are needed to carry off the additional surface water that comes upon it.

It will not require more than two or three weeks work by a competent gang under proper supervision to put all the existing ditches into proper shape. It will be necessary to compel those who have crossed by roads or embankments the line of drainage, to place culverts or proper outlets for the surface waters and it will be necessary to keep a closer watch on the improvements that may be made on the meadows.

But it was not the marsh mosquitoes that troubled Newark chiefly: indeed, after the beginning of July these dropped out completely as factors, and left only the house mosquito, *C. pipiens* as the offender.

The early part of the season was extremely satisfactory. Mr. Dobbins was well informed as to the danger points and as early as May 3rd had his gangs out, eliminating and oiling pools. It was realized that the sewer catch basins were the chief danger points in the city, and Mr. Dobbins contrived a very ingenious sort of arrangement to avoid the necessity for repeated oilings, with the numerous chances of overlooking basins here and there. It consisted of a 1-gallon tin can properly painted, and wired fast

ıderside of the basin cover. The can is filled with oil a screw top and has a small hole near one corner of the rough this a long wicking is inserted and reaches the f the can. It hangs down on the outside over the edge ıp, and reaches down outside a little below the bottom. lrops very slowly from the end of the wick to the sur- he water, and spreads over it gradually, forming a film ıtomatically renewed as often as it is broken.



iagrammatic sketch showing the Dobbins plan of continuous oiling in sewer catch-basins. Original.

thousand of these cans were prepared and, by June 6th, them were in place. Up to that time there had been f rain and the sewer basins were flushed so often that ling was possible. Mr. Brehme watched one of the

basins and verified the fact that after a complete flushing it was a matter of only a few hours before a new and practically complete film had formed.

Up to June 29th, no *pipiens* were found in the City and no breeding occurred in the catch basins. In early July the drought was on, and conditions changed. *Pipiens* began to appear in numbers, and while catch-basins were not at first suspected, they were eventually examined and an unexpected condition of affairs was found. In almost every basin there were sticks and other floating rubbish, and it appears that as the water lowered, there were separated pools formed by floating divisions that the oil would not cover. Where a basin was free from such rubbish—very few were so—no breeding occurred. In others, sometimes only a small area where the drop fell was covered, and a greater or less area was safe breeding place. And every such place was filled to the limit with wrigglers. Basins without cans, of which there were quite a number, had broods limited only by the capacity of the water to hold them. The City was filled before the conditions were realized. Mr. Dobbins then put his full force to the systematic oiling of basins and the broods were checked. But the mischief had been done, and so filled was the City with *pipiens* that all sorts of likely and unlikely places were used by the insects. In the outskirts of the city every brook was a series of pools, almost every pond was broken up, and *Anopheles* as well as *Culex* larvæ were everywhere. From the surrounding municipalities where nothing was done, swarms of specimens came into Newark and made matters worse. As there is practically no break in the buildings between Newark and some of the adjacent towns, the Newark force was practically helpless at such points and their labor was wasted.

Commissioner Dobbins put up an excellent fight and led it himself when he was through with his business for the day. Even on Sundays and Saturday afternoons he could be found on the oil wagon, and it was no fault of his that he did not win out completely.

Matters were bad enough; but they would have been infinitely worse had it not been for the excellent work done by Mr. Dobbins.

As matters stand at present writing, there is a terrific brood, *Anopheles* as well as *Culex*, in the city cellars. A few of them that have been examined, showed literally thousands of examples present, and systematic winter work is indicated as an important part of the local campaign against them.

ELIZABETH.

The first inspection of this meadow was made April 13th, by Mr. Brehme, and matters were found on the whole in fairly good condition except at one point. The first brood of larvæ had been almost completely killed off, and only fragments of the second remained. There was no hope of getting off all the water before the adults could hatch at the one danger point, and Mr. Richards was immediately notified of the necessity for applying oil.

May 5th, on a second inspection, a willful blockage was discovered, which flooded a small section of the meadow and permitted a brood of larvæ to start. Mr. Richards was notified of this condition also.

Mr. Richards has always been prompt in looking after the meadow conditions brought to his attention, and he put a gang on, under a proper foreman, so that June 13th, matters were found in very decent condition. There was a brood of very young wrigglers in one section just covered with a heavy rain, but the water was running off fast and, as a matter of fact, none of these matured.

There were no flights of salt-marsh mosquitoes in Elizabeth at any time during the season. Up to July 15th, Mr. Richards reported no trouble from that source, and on July 21st, at the isolation hospital at the edge of the salt marsh, out of 500 examples taken on the screens and preserved, not one was other than *pipiens*. Altho the marsh was by no means free of breeding during the season, conditions were so well looked after and the broods were so scant, that only occasional specimens were noted in the city

But about July 1st, *pipiens* began to appear and continued to increase abominably. There is no doubt that a heavy brood escaped in late June just before the oiling of sewer catch basins began. After that period very little could be charged to that source. July 21st only a single missed basin was discovered and that, of course, swarmed with wrigglers. The city was examined again and again by Mr. Richards and his men and on several occasions aided by Mr. Brehme; but not until toward the end of the season was the real source of the trouble discovered. Two city sewer outlets open upon the salt marsh in the northern part of the city and while one of them is well out on the marsh the pool formed breeds out countless numbers of specimens, many of which undoubtedly find their way into the city only half a mile away. The other is close to the edge of the city and was discovered in 1908. At that time a broad shal-

low outlet was dug to relieve the situation and during 1909 no trouble occurred. But the ditch was not deep enough to get below the cat-tail roots. They started again in the bottom of the ditch, and in 1910 the conditions were worse than ever. When the place was again looked over by Mr. Richards in 1910, conditions were almost indescribable and there was no further question as to the source of the house-mosquitoes in North Elizabeth and elsewhere in the City. Both these sewers should be carried to tide water through canals sufficiently deep to prevent their growing up again. It is certainly not a good sanitary condition to have the sewage from two quite important drainage areas spread broadcast upon a salt marsh and allowed to soak away and evaporate in the summer sun.

The salt marsh conditions in Elizabeth have never been satisfactory and cannot be made so without cutting the embankment of the Central Railroad of New Jersey. This point has been referred to again and again, and all sorts of experiments have been made to improve the drainage. Great Ditch has been improved, straightened, widened and deepened, and the railroad itself has contributed $1,000 to the cost of the work. Ditches have been added to each year, and the City, individuals and the State have contributed to the work. Over $500.00 was spent during the summer of 1910, of which $200.00 was contributed from the State fund. Withall, under storm and full tide conditions, the water simply cannot be drawn down on the Great Island section rapidly enough to prevent the issuance of a brood. There are ditches enough and the plan is right, but the outlet is so limited and the meadow so low that only during the end of the ebb is there any lowering of the ditches, and during anything like an extra high tide the meadow floods from several sections through sources by means of which very little can get out again.

The experience gained on the Point-No-Point area seems to indicate that when a heavy application of oil is made in spring, it lasts much longer than we had been led to believe, and during the season of 1911 I expect, if the co-operation of the City authorities can be gained, to try a series of experiments to determine the possibility of making a section of marsh mosquito-proof by means of oil and perhaps, one or two other materials. The cost would not be very great, and the information gained promises to be extremely useful.

A very interesting feature in this connection, illustrating the dependence of mosquito migrations upon the direction of the wind, is that Elizabeth got none of the mosquitoes bred on the Newark salt marsh, and very few of its own breeding. There

is considerable evidence, however, that the broods coming out on the Elizabeth area found their way far to the north.

LINDEN TO CARTERET.

The Linden Marshes south to Carteret were inspected four times during the season. On April 15th, Mr. Brehme reported conditions good except at or near Tremley Point. A sewer had been laid across the marsh at this point from Linden, and this had cut the drainage line of a number of the ditches which were blocked by the contractor in closing the sewer trench. This section of the meadow had been one of the worst for mosquito-breeding before the ditches were put in, and it had been particularly well ditched. It was discouraging to find that the Municipality itself paid so little attention to its own interests and to the comfort of its citizens, as to permit the work done to be interfered with. The board of health was notified of the conditions existing, but no attention was paid to the matter, and at the last inspection, late in September, matters remained exactly as they were in April. Several broods emerged from this territory and supplied Linden and Rahway with salt marsh species during the summer.

Rahway secured an additional supply from the north bank of the Rahway River, where several of the ditches were blocked by sods. As Rahway never paid the contractor for the ditching work ordered, it was deemed useless to notify the authorities, and the breeding on this area continued unchecked during the summer.

The work at *Carteret* approved itself throughout the season and very few mosquitoes developed on that area during the summer. The season was as little troublesome from the salt marsh mosquito standpoint as any within the history of the place.

WOODBRIDGE TO PERTH AMBOY.

Taken as a whole the conditions on this area were good throughout the season. On the Woodbridge and Seawaren meadows the ditches did their work well and there was no material interference.

Attention was called in a previous report to the fact that in the vicinity of Boynton Beach some filling had been done, and that this had resulted in shutting off a portion of the drained area. On this portion of the meadow mosquitoes were bred during the season, and Boynton Beach got the benefit of the sup-

ply. The local authorities were notified of the conditions but, so far as I could find nothing was done to improve matters. I did not consider it necessary to interfere further because the pest is practically a local one, and if the people of the vicinity prefer the conditions as they are, they might as well be left to enjoy them so long as they do not seriously interfere with the neighboring communities.

At *Perth Amboy,* which enjoyed almost complete exemption from mosquitoes in 1909, a flight of salt marsh species made their appearance in May, 1910. The local board of health requested the office to locate the source of the trouble and that was done by Mr. Brehme and myself, during the latter days of May.

The difficulty was found at *Maurer* where a meadow area had been ditched by the owners of the land. The ditches were not well put in, were allowed to become blocked at the outlets, and permitted the early broods to develop and escape in the surrounding territory. The Board of Health was duly notified of the findings and took prompt action. No further complaints were received later in the season, and that particular area was not again looked over.

RARITAN RIVER MARSHES.

These remained, on the whole, in satisfactory condition this year. A small portion of the area, in Woodbridge Township, had some of the ditches blocked and in this area a small brood emerged. In the early part of the season a combination of high tides and heavy rains prevented the rapid drainage of some of the lowest meadow areas; but on the whole very few specimens got out.

The local board of health in Raritan Township was notified of blockages occurring in its jurisdiction and, on June 1st, Mr. Woerner, Secretary of the Board, notified me that they had removed the obstructions. He added that during the day on the meadow his party saw and killed just three (3) mosquitoes! Certainly an excellent record on that territory for that season of the year. In fact there were really fewer insects on the meadow than were in the surrounding territory, because most of those that actually hatched migrated to the uplands. There were enough, all told, hatched along the river to give New Brunswick a sprinkling of *C. cantator* for a week, and thereafter for the season the territory was clear. The sum of $35.00 was spent on the meadow in going over the area and hooking out such sods and other obstructions as had fallen or been placed into the

litches. The Raritan Township board of health has posted notices warning against interference with the ditches; but in most places the owners and others driving on or over the meadow seem to consider themselves privileged to block as they choose, and free from obligation to remove the blockage afterward.

At the inspection made October 3rd, 1910, Mr. Brehme reported the meadows as being in good general condition and free from breeding at that season.

CHEESEQUAKE.

The Cheesequake Meadow continued its good record. It was noted in the last report that late in the season the gunners had blocked some of the ditches in order to flood the scalds that attracted snipe. The blocks were removed at that time by Mr. Brehme, but were probably replaced soon afterward. At all events in early May I met with some salt-marsh mosquitoes at Jamesburg, and sent down to the Cheesequake as the most probable source of supply.

May 16th, Mr. Brehme reported the meadow as a whole in excellent condition. The scald area was again found blocked and a small brood had, undoubtedly, issued in the meadow. The blocks were removed at once and the water drawn down rapidly in consequence.

July 8th, matters were found entirely safe. No breeding was going on, and not a dozen mosquitoes were found on the marsh or in the woods: nor had there been any during the early part of the season, according to the reports of the residents nearby.

September 23rd, conditions were reported as superb. All the ditches were working well and absolutely free. The meadow was dry—so dry that no snipe were shot during the season, as their feeding grounds were grown up in grass. Mosquitoes had been scarcely noticed throughout the season. *Pipiens* was never a factor in this locality, and the salt marshes having been made safe, the territory had completely changed its character. The number of camps along shore was increased by ten over the last season's increase, and they were fully occupied throughout the summer. Where, in times past it had been a continuous battle with mosquitoes, people now came from cities to seek relief from the sewer-bred pests.

No money was spent on this meadow during the year and unless there is further willful interference there is no likelihood that any will be required during the year to come. The purchaser of the hay crop on this meadow is one of the few of his

clan who realizes the value of the drainage work to the meadow, and he never interferes with any ditch.

MONMOUTH SHORE.

May 27th, Mr. Brehme began an inspection that covered the territory included in the Cliffwood, Matawan, Keyport, Union, Keansburg and Port Monmouth Meadows. Everything was found in excellent shape. There were a few sods in some of the ditches, but the drainage was nowhere interrupted and all the meadows were dry. Not over a dozen mosquitoes were found on the entire stretch which, considering conditions elsewhere at that time, was a sufficiently good record. No larvæ at all were found. A number of persons were questioned as to conditions and agreed that up to that time there had been no mosquitoes.

On the Union meadow where a land company deranged the drainage scheme by running streets and roads, the same company had restored the good conditions by additional drainage work so that no complaints could now be reasonably made.

October 4th, the record at Cliffwood and Matawan was equally good. All the ditches were working nicely, the haymakers were guarding them in their operations, and not a breeding pool was found. The general report was that there had been few mosquitoes of any kind during the season, and the value of the ditching work was now fully appreciated. Not a cent was spent on these meadows during the season and most of the sods had either grown fast or had been used in one way or another by the owners.

On this point the Secretary of the Keyport Board of Trade wrote me, June 2nd, 1910, as follows: "Regarding the mosquito pest would state that this section seemed to be absolutely free from same last season and it is believed that your work in this vicinity has had a highly satisfactory effect."

June 7th, the inspection between Keyport and Belford showed everything in good condition and during the entire season not a complaint was received. The October 6th inspection showed equally good conditions and not a complaint was heard. On the contrary, several of those who derided the work when it was done, declared it impossible to surface drain so as to prevent mosquito breeding, now declared themselves fully convinced of their error. Their being no opportunity for *pipiens* breeding, the areas were practically mosquito-free all summer.

June 8th, the meadows from Belford to Atlantic Highlands were inspected and conditions were not quite so good as in the

ther sections. There were some blockages and there had been little breeding. A few *sollicitans* were found on the meadows; ut nobody had put up porch screens as yet. Mr. Brehme ecommended that the meadow be gone over carefully and the itches cleaned, and that was done at an expense of $22.50.

For the balance of the season conditions remained satisfac- ›ry, and on October 7th, all the ditches were in good shape and either larvæ, mosquitoes nor breeding pools were found on the ıeadow. The record from the Monmouth shore is almost erfect.

SHREWSBURY RIVER MARSHES.

Extensive alterations and improvements have been made on ıe Rumson side of the Shrewsbury River, which have resulted ı an entire change of conditions there. At first, early in the ason, the change in the drainage system resulted in an accumu- tion of water that permitted the development of a large brood f salt-marsh species in late May or early June. At the request f the parties concerned I had Mr. Brehme make a careful sur- ey of the conditions as they then existed and sent a report with ıggestions to the managers of the Country Club, under whose ıspices the changes had been made. Later in the season I went ver the territory myself, and by that time most of the sugges- ions had been complied with. Altho a temporary revival of ad conditions was caused by the work done, the ultimate result ill be beneficial and, as improved, the territory will need less ›oking after than it does now. Later in the season conditions hanged, and no further difficulty was experienced with the salt ıarsh pests.

On the east side of the River the conditions have not changed uch. The ditches have been kept open and they have done eir work fairly well. The trouble, such as it has been along is territory, has been due to *C. pipiens*.

This Shrewsbury River drainage work was the first of its kind ne in the State, and was to a considerable extent an experi- ent. Defects and errors have become obvious and should now corrected. It was a mistake to take the ditches directly into e river where they are subject to blockage by sand and sea- ed, and require more supervision than was expected. Further perience has shown that in such cases an indirect outlet is bet- , and needs practically no attention. We have also learnt, experience, that a 6 by 20 inch ditch is much less effective than somewhat wider and much deeper one, and that at a 20 or even 24 inch depth there is danger of growth from the bottom.

I have had Mr. Brehme look over the area carefully, in the light of our later experience, and he reports that for $1,000 the territory could be practically re-drained with 10 by 30 inch ditches with outlets safe from blockage, and in such a way as to require looking after only once in early spring to remove accidental winter blockages.

MANASQUAN TO BAY HEAD.

The marshes at Manasquan remained in good condition throughout the season and very few mosquitoes were developed there at any time. The first inspection was made May 13th, and showed some obstructions in the ditches and a very few resulting pools; but nothing like a brood, despite the heavy rains and high tides. A week later, after another series of tides and rains, the meadow was again visited and found practically safe. The depth to which the meadow had been covered and the rapidity with which the water drained away, was illustrated by the hundreds of large crabs lying dead on the surface because they had been unable to follow the water out fast enough. In view of the fact that this meadow is so low and liable to overflow by any extra or storm tide, it was deemed best to have the ditches cleaned, which was done at a cost of $15.00. Thereafter no breeding was reported, and on the last inspection, October 12th, everything was in excellent condition and no mosquitoes were present in any stage.

Sea Girt and the State Camp-ground used to get their chief supply of mosquitoes from this Manasquan meadow. Such reports as were received from the soldiers there encamped, indicate that very few of the pests were present during the summer of 1910, and from collections made at different times, it was determined that these were nearly all *pipiens,* bred on the camp ground itself.

So the mosquitoes that were noted in Manasquan were practically all *pipiens,* bred in the rain barrels and cess-pools of the town itself.

Point Pleasant had small flights of salt marsh mosquitoes on south winds on a few occasions, and that was not unexpected, because of the undrained areas only a few miles south: nevertheless even here the greater portion of the specimens collected by Mr. Brehme in early August were *pipiens* and some of these were bred in the street gutters in the town itself. I noted that myself, within 200 feet of the Railroad station in gutters on the main street, and there is no difficulty in accounting for such infestation

as was found. On the other hand it would be a very simple and easy matter to clean up this pretty little place so as to free it of the local species almost entirely.

At *Bay Head,* there were more salt marsh mosquitoes, and that was not surprising either, because on every south wind specimens came in from Mantoloking and southward, where no draining has yet been done. But even here there has been a great improvement, and there were nearly as many *pipiens* as *sollicitans*: in fact the former were a great deal more annoying because of their house-infesting habits. No effort has been made to locate the breeding places of this latter species.

Mr. Brehme reported some complaints on his visit in early June, and the matter was referred to the local board of health. The effect of some of the dredge filling here, in connection with the inland waterway work, remains to be determined.

BARNEGAT BAY.

On this area work was done from *Bay Head* a short distance south toward *Mantaloking* on the shore strip. So far as our work was done there it maintained itself well; but so much breeding occurred just south of our work and among the sand hills, that there were plenty of mosquitos, some of which extended into Bay Head. Nowhere could the sharp difference between drained and undrained areas be better observed than here.

On the western or mainland shore, the territory between Bay Head and Island Heights was twice covered—June 9th, and September 30th. While this long stretch of meadow was by no means entirely free from mosquitos throughout the summer, they were so materially reduced as to be practically unnoticed for most of the season. The winter tides had blocked some of the ditches, but not so as to interfere seriously with drainage conditions and it was deemed best to let matters rest during 1910, but to clean out and make necessary repairs or additions in the spring of 1911. Toms River derived material benefit from our work, but Island Heights not so much. The marshes just to the south supplied the latter place, while Toms River was a little off from the direct line of flight. It is extremely probable that many of the mosquitoes actually found on the drained meadow never bred there. In fact we know that flights from the undrained marshes south of Toms River actually extended into Bay Head on persistent south winds, on two several occasions. But there was a very material improvement in conditions that was recognized by the residents, who also noted the improved con-

dition of the meadow and the vastly better grass that it grew during the season. The summer of 1911 will furnish a better test of the results of this work.

LONG BEACH.

Long Beach extends from Barnegat City to Sea Haven, a distance of about 22 miles. Almost in the centre of the Beach is Barnegat Junction, where the trains diverge, north to Barnegat City, south to Beach Haven. Beach Haven is at the end of the Railroad to the south, but the strip extends southward for about six miles more, to Sea Haven. On this stretch there are practically no inhabitants save those connected with the life-saving stations, and a few at the new Sea Haven settlement.

South of Barnegat Junction, Long Beach has been drained, filled and otherwise freed from mosquito breeding areas to the end of the beach, and in 1909 the whole territory was examined early in the season and a small sum ($40.00) was spent to put into shape some blocked areas. It goes without saying that very little was expected from our work by the permanent inhabitants when it was first done. Since then there has been a revolution in opinion. The results were good in 1909, but in 1910 they were even better, and stood out in strong contrast. North of Barnegat Junction mosquitoes were plentiful and troublesome all season, and Surf City, Harvey Cedars and Barnegat City were scourged. South of the Junction there were mosquitoes only twice during the summer and they came in, both times, on a west wind from the marshes at the edge of the mainland. These flights were noted at Beach Haven and at both life-saving stations, and all hands were positive that they were not locally bred. There is a unanimity of opinion that there never were so few mosquitoes on that beach, and the practical effects were as satisfactory as the fact itself. There never was a more successful season and all accommodations were taxed to the limit. Guests remained their full time or longer, and people were turned away for lack of room from all houses.

The local authorities looked after the ditches within their jurisdiction and, in late September when Mr. Brehme covered the territory, everything was in first class condition. The crews of the life-saving stations had recognized the benefits derived from the ditches, and had voluntarily looked after our big main ditch south of Beach Haven. I had been afraid of this ditch: it is in pure sand; but the sand is moist and firmly packed. It has now stood for three years and is still perfect. A little growth

has started here and there, but this has not interfered with the drainage, nor does it seem likely to do so in the near future.

The Railroad company has kept the ditches open along its line of way, and these give outlets to many of our smaller ditches. All the filled areas are still perfectly level, and our scheme of rubbish filling and sand weighting, has proved entirely successful.

Nothing was done for our artificial ponds among the sand hills during the season of 1910; nevertheless they were found in perfect condition after three full seasons of wear and tear. Every pond carried water throughout the summer, and in all save two, fish were still found active and in good condition. There had been breeding in some of the ponds, and both large and small fish were seen. In others there were no small fish, and those present were unusually large.

Two days were spent in the inspection and, though the weather was favorable, scarcely a mosquito was seen on the entire trip and none were noted on the hotel porches at night. Not a wriggler was found during the two days! At Barnegat City Junction, however, there were plenty of specimens, and at Barnegat it was necessary to keep up a constant fight while waiting for trains. The practical freedom of the area south of the Junction as compared with the serious infestation north of that point can be attributed only to the work done by this service. Not a cent of state money was spent on Long Beach during the season of 1910, and nothing was necessary to maintain the effectiveness of the work.

FAIRFIELD TOWNSHIP.

This township lies south and a little to the west of Bridgeton, south and east of the Cohansey Creek, extending to the Delaware Bay, and contains about 11,345 acres of virulent, mosquito-breeding salt marsh. The direction of the prevailing summer winds is such that Bridgeton, Fairton, Greenwich and other neighboring settlements get a large percentage of their mosquito supply from this area, and as this means a large permanent population, it was considered desirable to begin drainage work here.

Mr. Brehme had been over this general area at the time the estimate for clearing the State was made, but no ditching plans had ever been drawn up. During the last days of April therefore, as soon as money became available, several days were spent in making a general survey, from which a ditching scheme was worked out later, by Messrs. Brehme and Grossbeck.

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The Railroad company has kept the ditches open along its line f way, and these give outlets to many of our smaller ditches. All the filled areas are still perfectly level, and our scheme of rubish filling and sand weighting, has proved entirely successful.

Nothing was done for our artificial ponds among the sand hills during the season of 1910; nevertheless they were found in perfect condition after three full seasons of wear and tear. Every ond carried water throughout the summer, and in all save two, ish were still found active and in good condition. There had een breeding in some of the ponds, and both large and small sh were seen. In others there were no small fish, and those resent were unusually large.

Two days were spent in the inspection and, though the weather as favorable, scarcely a mosquito was seen on the entire trip nd none were noted on the hotel porches at night. Not a wrigler was found during the two days! At Barnegat City Junction, owever, there were plenty of specimens, and at Barnegat it was ecessary to keep up a constant fight while waiting for trains. he practical freedom of the area south of the Junction as comared with the serious infestation north of that point can be atributed only to the work done by this service. Not a cent of tate money was spent on Long Beach during the season of 1910, nd nothing was necessary to maintain the effectiveness of the ork.

FAIRFIELD TOWNSHIP.

This township lies south and a little to the west of Bridgeton, outh and east of the Cohansey Creek, extending to the Delaware ay, and contains about 11,345 acres of virulent, mosquito-eeding salt marsh. The direction of the prevailing summer inds is such that Bridgeton, Fairton, Greenwich and other eighboring settlements get a large percentage of their mosquito pply from this area, and as this means a large permanent popation, it was considered desirable to begin drainage work here. Mr. Brehme had been over this general area at the time the timate for clearing the State was made, but no ditching plans ad ever been drawn up. During the last days of April therefore, soon as money became available, several days were spent in aking a general survey, from which a ditching scheme was orked out later, by Messrs. Brehme and Grossbeck.

On May 20th, I served the necessary preliminary notice on Mr. Charles H. Nichols, secretary of the Township Board of Health, at Fairton, and on June 6th, I attended a meeting of the Board at that place. I explained to the members very fully what was intended and, as this was the first work done in that section of the State, went into some detail concerning the effects of the drainage on the marsh itself. The board acted promptly and cordially, and thereafter I had the full support of its officials and members throughout the summer.

The necessary notices to owners were served promptly and returns from the board and Township committee were received as required by law. On my recommendation the Director set aside out of the available appropriation the sum necessary to drain about 4,000 acres of the marsh area involved, and advertisements calling for bids were inserted in the Bridgeton Pioneer, the Bridgeton Daily News, and the State Gazette at Trenton.

Bids were received July 1st, and the contract assigned to the U. S. Drainage and Irrigation Company of New York City, which was the lowest bidder, for the sum of $5,949.00. All the requirements of the law were complied with by said company, and work was started July 15th. Trouble began almost at once. The weather was intensely hot, there was scarcely a breeze stirring on the marshes, the mosquitoes were present in countless numbers and, in addition, green-head flies came to the attack in swarms. The tools provided were not sufficient for the work required, and progress was so slow that there seemed no hope of completing the contract within the time limit.

Mr. Brehme notified me promptly of these matters, and on July 20 I went over the ground with him, myself. At this time the work had been completely abandoned and the shelter tent put up for the workmen had been burnt. Only a small part of the ditching work had been done, and none of that complied with the specifications.

Ten days later the work was again under way, but the ditches were not up to requirements in any way. The attention of the contractor was called to the matter and the company was notified that the ditches as cut could not be accepted as complying with the specifications. The time limit for the completion of the contract was August 15th, but, up to that time, not even the first payment had been earned altho almost half the number of feet of ditches had been put in:—the ditches were none of them of the required depth. The Trust Company that furnished the contractor's bond was notified of the failure; but the contractor was allowed to continue work. Thereafter better work was done and the ditches

were cut to scant contract depth, so that by August 25th, ten days after the contract should have been completed, one fourth of the work was passably done. Not until September 17th, too late to be of any use for the season of 1910, was the work finally completed so that it could be considered acceptable. It is not in any way up to the standard of work recently done by another contractor and, altho the bid was a little the lowest, the difference was more than balanced by the additional cost of the supervision work and the delay in completion.

Even as it was, the ditches caused a simply marvelous change in the character of the meadow, and already areas from which no grass had been cut for years, have a luxuriant crop fit to be harvested. The character of the soil is good and the meadow drains well, so that practically all surface pools have disappeared.

Three hundred and twelve thousand (312,000) feet of ditching were required under the contract and that amount has been put in and does the work required, in a satisfactory manner. No breeding was found September 15th, while on the adjacent, undrained marshes there were surface pools in abundance, and plenty of mosquitoes in all stages.

While the work was going on as above described, and for the purpose of comparing two methods of work and tools, I assigned a small, separate area of 650 acres, to Mr. Jesse P. Manahan, of Red Bank, New Jersey, for $900.

This work began during the early days of August, was done by a power machine and was completed during the first days of September. These ditches and the general character of the work were in all respects satisfactory, and form a strong contrast to the spade ditches of the previous contract. They will stand better and because of the great size of the sods taken out there is much less danger of their floating in and causing blockages during the winter storms.

ATLANTIC CITY TO CAPE MAY.

No work has been done by or under the direction of the executive officer between Atlantic City and Cape May; but many of the communities along this stretch of shore have been in consultation with him and considerable work has been done at his suggestion. A number of the most important shore resorts are between these points, and conditions have changed materially since the first surveys were made. With every passing year further changes are made and every change means some improvement of local conditions. The improvements, however, are

almost all confined to the shore strip and have little or no eff upon the marsh area between that strip and the edge of the ma land. I have made it a point to keep posted as to the chan taking place from year to year, and spent four days in ea August, covering the territory, beginning at Cape May.

Old Cape May is, at present, the least progressive of the lar shore resorts. The line of steamers from Philadelphia to Ca May Point has been abandoned, the buildings at the point a going to pieces, and the entire stretch between the Point a Cape May City looks dreary and desolate. No improvemen have been made on the Cape marsh and one of the best natu situations on the coast is left to decay.

At West Cape May and in Cape May City, there have been few changes as compared with previous reports, except along the line of New Cape May toward Sewells Point. Old Poverty Beach and the marsh extending north of it to Schellengers Landing have been transformed. From a virulent mosquito breeding marsh area it has been changed to a level sand plain on which some vegetation is now appearing, and cut up with streets and avenues along which some buildings are now in course of erection. The work on the harbor is now actively in progress, and it is only a matter of a very few years when this will be an attractive and important settlement, accessible by both rail and boat from New York City. Mosquito breeding areas here have been completely eliminated over most of the area, and only isolated places remain along its borders. These can be easily dealt with when matter are further advanced, or whenever public sentiment really de mands it. Under present conditions there seems to be no nee of interference with normal progress by ditching or draina operations.

Two-mile beach is also in progress of improvement. At southern end jetties are being constructed in connection with harbor work, and dredging and filling operations are improv the adjacent areas. The entire beach front has come into hands of a large holding company, and it is marked for early provements which will eliminate what breeding areas now on that territory. None of these improvements, be it noted tend toward the mainland, and the breeding places there remain unaffected by the work as already planned.

Five-mile beach has been completely transformed since m report on its condition. Marshes have been filled, acres o territory have been created, and a straggling settlement ha transformed into a living town. From Anglesea to Wil Crest, the transformation has extended and only in Angles

in Holly Beach do any salt-marsh breeding places remain. In Anglesea the areas are small, and the nuisance created by them can easily be abated by the Board of Health whenever it deems it necessary. At Holly Beach the area is larger, and forms the only serious blotch remaining on this beach. The effect upon mosquito conditions has been wonderful. At Anglesea, where in times past clouds of the pests were accepted as a matter of course from early spring to late fall, there was trouble for only short periods when the winds came for two or three days from the main-land. During a two day and one night stay, I met with less than half a dozen specimens and sat during the entire evening without hearing or feeling a single specimen. It will need only a little more well directed draining and filling to make this entire island safe except from main-shore flights.

Seven-mile beach from its southernmost point to Stone-Harbor has been little changed and is still a virulent mosquito breeder. At Stone Harbor, conditions are very much as I described in my report for last year so far as the surface features are concerned: There has been very little more grading or filling; but there have been quite a number of buildings erected, some of them rather pretentious.

Between Stone Harbor and Sea Isle City there has been more or less filling and draining, and some oiling of ditches and pools; but nothing in the way of systematic work and no co-operation. Thus, while there has been a very great improvement and a material lessening of mosquito breeding places, there has not been any very apparent lessening of the annoyance caused by the insects.

At and near Sea Isle City, a rather ambitious scheme to form a modern Venice is under way. From the Thoroughfare at the west of the City a system of parallel canals has been dredged, and the space between them has been filled. Streets have been laid out and in part curbed and graded, so that the outline of an elaborate system is in place. This work has resulted in the improvement of many acres of mosquito breeding marsh-land, and will no doubt improve conditions materially. But along the edges of the work there were plenty of mosquitoes and there was plenty of breeding territory. Practically no building is going on and, to all appearance, no actual dredging was done during the season of 1910.

North of Sea Isle City, to Corsons Inlet, practically no change has taken place and conditions are much as originally described. From Corsons Inlet to Ocean City there is greater activity, and much improvement has been made. Most of this, however, is

confined to the beach front, and west of the settled line the marsh area has been left practically untouched until the central town itself is reached. There is plenty of work to be done everywhere within Ocean City limits, and a great deal of it could be very easily done through intelligent local direction.

Somers point has changed little for the better since my original investigation. There have been additions and improvements here and there; but nothing that has materially affected the mosquito supply.

At Pleasantville, on the contrary, there has been a great deal of recent improvement in the way of dredging and filling. Indeed there is very little actual breeding ground within its own jurisdiction, and the existing supply comes from the surroundings.

On Absecon Island and in the immediate vicinity of Atlantic City, improvements are continuous. A new sand-filled area, "Venicea" is in course of development, and has eliminated a nasty breeding territory north-west of the City. The net-work of roads and railroad dams crossing the marsh from the mainland to the Island has resulted in some stagnant areas, and in the formation of some dead pools which will bread mosquitoes. It will not be difficult, however, to make a satisfactory drainage scheme whenever it becomes desirable to do so. At the present time so many private enterprises are under way and so much unconnected drainage and filling is done, that State work seems premature. It is not improbable, however, that it may be desirable, in the near future, to co-operate with some of the large improvement schemes that will result in the elimination of breeding areas along the edge of the mainland. From Atlantic City to Longport, conditions have changed completely since my original survey. Almost all the salt marsh from the beach to the edge of the Sound and Thoroughfare has been sand-filled, and much of it is built upon. Practically all this area is now out of the field of the State work.

The net result of this inspection survey shows that a very great area of salt marsh has been redeemed by drainage or filling, and will not need any attention from the State as the mosquito work goes on. It also develops that this territory should be protected by State work along the mainland; for until such work is done, those investors along shore who have made the improvements, will not derive the full benefit to which they are entitled.

MISCELLANEOUS INSPECTIONS.

Quite a number of communities were interested enough in the mosquito campaign to ask for help and reports on their local conditions. In all cases these were responded to, and a few of the more important are referred to here.

Chatham asked for an inspection early in the season, and on April 6th, Mr. Grossbeck spent the day in company with a local inspector in locating the sources of supply which were found unexpectedly numerous yet comparatively easy of control. A lecture, soon after the inspection, advised the community of what measures were necessary, and early in May, work began. Mr. Grossbeck looked over the town again on May 20th, and found that almost every dangerous point had been properly dealt with. Incidentally, he also found that the day before a flight of *cantator* had reached the town from the Newark marshes, and that these were then more troublesome than the locals, which were present in small numbers only.

Hasbrouck Heights was visited May 27th, by Mr. Grossbeck, and a report upon conditions found was made to the Board of Health. This was one of those instances that proved the probable freedom of suspected areas, and the fact that the inconspicuous places are really most to be dreaded. Here also the influence of the salt marsh conditions was felt, for specimens of *cantator* were observed in small numbers. Evidently the same light that supplied Chatham, reached this place as well.

Grantwood was inspected at the request of the local improvement association April 20th, by Mr. Grossbeck, and the few danger points in that community were pointed out. This place, as was pointed out in a previous report, lies in the line of flight of the mosquitoes breeding in the Bronx district of New York City, and may get a large percentage of its troubles from that source.

Essex Fells was inspected for the Board of Health May 31st, and again June 23rd, by Mr. Grossbeck. *Cantator* of the same day flight were found here also, in small numbers, in company with two species of woods mosquitoes bred within the place and with *pipiens*. On the latter date the salt marsh and woods mosquitoes had disappeared and *pipiens* alone held control. Fortunately it was easy to locate the chief source of supply in a sewer ditch, and the Board readily undertook to look after this during the season.

The shores of the *Pompton* Lakes and *Cedar* Lake were examined at the request of the owners May 16th, and 17th, respec-

tively by Mr. Grossbeck, and recommendations for the improvement of conditions were made. These places afford unusually favorable opportunities for *Anopheles* breeding, and the indications are that this is the chief pest in those localities.

Pyne Point Park, in Camden County was inspected for the owner, August 15th, by Mr. Dickerson, and the breeding places that gave the local supply were found and pointed out, with directions as to how they might be abated.

Millburn and *Short Hills* were kept under intermittent observation to determine that a very small brood of the woodland species occurred early in the season, and that there were pools and ponds where, later in the season, under such conditions as existed in 1910, both *C. pipiens* and the species of *Anopheles* might breed.

East Orange was inspected during the season by both Messrs. Grossbeck and Brehme. Early in the summer the Waverly meadows gave a temporary supply of *cantator;* but later this was effectively and efficiently replaced by *pipiens.* Four streams run from East Orange into the Vailsburg section of Newark, and every one of these bred mosquitoes in any quantity. In the southern part of the City every sewer basin in late August was a squirming mass of wrigglers, mixed with pupæ from which adults were constantly emerging and topped by egg-boats from which young slipped into every crevice left by the emerging adults. Absolutely nothing was done to check this, and for weeks every sewer catch basin gave a daily supply of hundreds of mosquitoes. In addition, several water-filled cellar foundations added a few millions. Many of these, as already noted, slipped across the line into Newark and other adjacent territories, adding to their supply without leaving any noticeable deficiency at home.

East Orange is an enterprising municipality in many directions, with an abundance of civic pride an an excellent class of inhabitants. But it had nothing to be proud of in its mosquito mills during the season of 1910.

Arlington was visited after midsummer, to determine the character, extent and source of the mosquito infestation complained of. No salt marsh species were found, even in the outskirts along the edges of the swamps, but *pipiens* was plentiful everywhere. The source in part, was easily located in the sewer basins which had not been oiled or otherwise treated. Every basin examined had its thriving wriggler population in every stage of growth, so that an uninterrupted supply was kept up until the heavy rains of late fall. In addition the disused Res-

ervoir of the old Jersey City Water works produced a few extensive broods that spread over the neighborhood in every direction.

Harrison, besides its sewer-basins, secured a local supply in Lamp-black swamp which is or has been used in part as a dump and is now in such condition that drainage is impossible.

Kearny was not behind its neighbors in its sewer basin supply; but had an additional source in the sewer outlets opening on the meadows and along the course of the sluggish Franks Creek, which is itself little more than an open sewer, gradually working into the Passaic to thicken the liquid there.

The *Belleville* supply came, in the eastern section of the town from the ponds in Hillside Park, while in the Silver Lake and Soho sections the trouble came from the brooks, pools and gutters into which the waste water is run.

Nutley may have gotten a few mosquitoes from the brook within its own limits; but the major portion of them came from Hillside Park, located in Belleville. This little town is very favorably situated and should be very easily made safe if its neighbors are good.

In *Bloomfield* the eastern portion, adjoining Belleville, obtained its supply from the lovely brooks, pools and gutters so characteristic of that section. The central town depended upon the sewer catch-basin supply, and possibly a small addition from the brook.

Montclair's trouble came from catch-basins, brooks, and the buckets in the main sewers, which served as excellent sources of supply. I might add, here, that all this region had some salt-marsh specimens in late May and early June; but that everything sent in later proved to be *pipiens.*

In *Verona* the brooks in the town were solely at fault.

Orange, apparently derived all its local supply from the sewer basins. There were, probably, a few accessory sources of supply but they were not located and were insignificant in comparison with the sewers.

In *West Orange,* the chief source of supply came from the brook that runs along the track of the swamp line trolley.

South Orange derived a part of its supply from the same brook and from several others which run through the town. An especially bad offender of this class was the brook that runs back of Seton Hall College, and belongs in part to South Orange and in part to Newark. The sewer basins contributed a share to the whole, so as to make a respectable showing.

Irvington is especially blest with brooks, and all of them were conscientious breeders during the summer. A number of pools throughout the town added their quota, and were notably and nobly aided by the Augusta Street swamp. This latter place, by the bye, is an especially bad breeder at all times, and as the new park near by is now nearly completed, it seems desirable that some steps should be taken to eliminate the nuisance. There will be little inducement, otherwise, to use the park at night.

It is suggestive to note in the records of these towns in Essex and Hundson Counties, how large a proportion of the local supply is sewer bred. Also that, during the last season the little brooks and streams became bad breeders where under normal conditions few if any mosquitoes could develop. Keeping these localities in mind, it is also easy to understand how an abnormally dry season can in such localities be much more favorable for mosquito breeding than even a somewhat abnormally wet one.

The very conditions indeed, that favored us during the latter half of the summer on the salt marshes, was against the organizations carrying on local city mosquito work.

ANOPHELES AND MALARIA.

It has been incidentally stated that the conditions that developed during the summer favored the increase and breeding of the *Anopheles* as well as *Culex*. The direct result was also a material increase in the number of cases of malaria. From a number of sources the prevalence of the disease was referred to, and in one case we learnt of the prevalence of the disease after we had demonstrated the occurrence of the mosquitoes. In other instances physicians applied to the office for assistance in locating the source of the mosquitoes that favored the spread of the disease. In every case the locality in fault was discovered, and in almost every case prompt measures were taken to eliminate the source of the trouble.

In one case the co-incidence in the distribution of insect and disease was truly remarkable, the distribution of *Anouheles* having been worked out by Mr. Brehme, while the distribution of the malaria was independently worked out by a local physician.

There are at present large numbers of *Anopheles* in hibernating quarters, and there are also an unusual number of malarial subjects in a more or less infectious condition. Circumstances are therefore favorable for an epidemic of malaria in 1911, where no precautions are taken. Every physician who has had

. case of malaria should see to it that his patient is as completely reed as possible from all trace of the disease, and every board of ıealth in whose jurisdiction the disease has occurred, should :arry on an active campaign of winter fumigation of cellars of he infected and neighboring houses.

WINTER WORK.

Emphasis is placed on the importance of winter work during ›resent conditions, particularly in view of the fact that among he specimens now in hibernation there are an unusual number of *4nopheles* and these, if spring and early summer conditions are :avorable, may prove the nucleus for starting a real malaria epi-lemic.

A tried and effective method of destroying the hibernating ;pecimens in cellars, store houses or wherever else they occur, is :o fumigate with *Culicide*. This has been used in the yellow-fever work of the U. S. Marine hospital service, and to a small :xtent in New Jersey: always with good results.

It is made of equal parts by weight, of carbolic acid crystals ınd gum camphor. Melt the acid crystals over a gentle heat ınd pour slowly over the gum, which should be broken up into ımall pieces. The acid disolves the camphor and makes a clear, omewhat volatile liquid, with rather an agreeable odor. This olution is permanent and may be kept indefinitely in tight jars. Jse 3 liquid ounces of this Culicide for every 1000 cubic feet of pace, and volatilize slowly over a lamp of some kind. A ımple and inexpensive apparatus for that purpose consists of n eight-inch section of galvanized iron stovepipe, cut so as to ave three legs, and with a series of one-quarter-inch holes near ıe top to provide a draft. Upon this place a shallow, flat-ɔttomed basin to hold the Culicide, and beneath this use a lass or other alcohol lamp. Three ounces of Culicide may be /aporated with less than an ounce of alcohol in half an hour, ıd the vapor should be allowed to act at least one hour and pre-:rably two or more. Culicide is inflammable but not explosive, nd should be used on a brick, earth or cement floor, or on ricks in a tub of water, to prevent fire. The fumes are not angerous to human life and it is quite practicable to remain in cellar undergoing fumigation until the vapor becomes quite ense and the material is more than half gone. Nor does it arm fabrics or metals, altho I would hardly advise the exposure f delicate colors or fabrics to its action. The combination is,

of course, also a deodorizer, disinfectant and to some extent a germicide. Flies and other insects succumb as readily as mosquitoes.

Where a very large cellar is to be treated two or more stoves should be used so as to fill the space as rapidly and completely as possible, and it goes without saying, that the space to be fumigated should be as completely and tightly closed as possible.

Mosquito campaigns are under way in a number of European cities, usually under municipal control and, among others, the City of Leipzig, in Germany, has been very active and has issued instructions for treatment at all seasons. The winter treatment is also by fumigation, and the following formula is recommended:

400 parts Spanish (Cayenne) pepper, ground.
200 parts Dalmation—or Persian insect powder.
200 parts Valerian roots, pulverized.
200 parts saltpeter.

Of this, use 3 tablespoonsful to 150 cubic feet of space. Place in small heaps on inverted, slightly raised, plates or dishes of any kind, and light at one or more points as needed. The cellars here also should be tightly closed and remain so from 2 to 3 hours. This vapor is also harmless to fabrics and metals; but is very irritating to man and other animals. The materials, and especially the insect powder (pyrethrum) should be fresh and of full strength, to obtain the best effect.

This combination has not been tested out in this country so far as I know.

NOTES ON THE HABITS OF CERTAIN SPECIES.

During the time that our species of mosquitoes have been under observation, a great many interesting facts have been noted from year to year and I asked Mr. Grossbeck, prior to the date of his resignation, to prepare in somewhat systematic shape such notes as had been accumulated in his experience, working in those of the rest of the force as well. These notes, prepared by Mr. Grossbeck, form the basis of the present essay, although given in a different order and in a less individual manner. I have, however, deemed it well to preserve those personal notes and experiences that illustrate the habits of species, and wherever a sentence, phrase or paragraph appears as a quotation, it is from Mr. Grossbeck's notes.

Forty-five species have been listed from the State of which one, *C. atropalpus,* yet remains to be found. No systematic collections have been made along the rocky shores of the Northern Delaware where only, if anywhere, the species can occur.

Five of the species belong to a series incapable of biting, and now separated off as a distinct family, *Corethridae*—in other words they are no longer regarded as true mosquitoes. That leaves us 40 species structurally capable of biting tho, as a matter of fact, some have never been actually known to pierce the human skin even where there has been opportunity.

Four species are salt marsh breeders exclusively: *sollicitans, cantator, taeniohynchus* and *salinarius.* Of these the first three breed in brackish or salt water and are migrants, the fourth breeds only in fresh or slightly brackish water and is not migratory. The latter has all the normal habits of the house-mosquito and, in the adult stage, can scarcely be differentiated from it.

Sollicitans, cantator and *taeniorhynchus* bite at any time, day or night, whenever they are started up, but fly to the attack only in the early evening. All of them alight and bite without lengthy preliminaries and never voluntarily change their position until gorged. They sing little or not at all and, while they do not leave their shelter voluntarily during a sunshiny day, will follow a victim that disturbs them, a considerable distance from the marsh. On sultry, cloudy days they fly at all hours and seek porches. None of these species make special efforts to get indoors. They will follow a victim, or will fly through an open door or window; but they are easily screened out. Most persons are quickly inured to the bites of these species. They rarely produce swellings and if the bite is not scratched or rubbed, most persons suffer only from the immediate puncture. All the members of the office force have been attacked by hundreds of specimens during a marsh trip, and have been bitten on every exposed part of the body. It was unpleasant enough at the time, and I have at times been literally driven off—yet half an hour after leaving the marsh, not a trace of pain or swelling remained. Few of the marsh hay-cutters seem to mind them much, if at all, and it is a common sight to see several mosquitoes filling up on their hands and faces without their being in the least aware of it. "I have frequently watched a *sollicitans* or a *cantator* drawing blood from my hand without feeling the slightest pain: on other occasions I have pounced on the culprit with a vicious slap, in my haste to terminate the acute pain at once." There are a few individuals however, that are unusually sensitive to the attacks of this species, and I have seen an instance where out of a party

of a dozen men on the porch of a shore club, one was so badly affected that his neck and face puffed up so as to be almost unrecognizable, while the others were not at all affected. All these species attack the ankles whenever possible.

Of the three, *cantator* has the migratory habit best developed. It leaves the meadows earlier in greater proportions, and flies farther than *sollicitans*. *Taeniorhynchus* is comparatively rare and does not fly as far as either of the others. So *cantator* probably lives longer than *sollicitans*. When, in early summer, a heavy mixed brood of *cantator* and *sollicitans* emerges, the former is first seen in the surrounding country, and in a few days the meadow will be almost bare of *cantator*, leaving the other as, apparently the chief inhabitant. And when *cantator* has accompanied *sollicitans* in a flight, worn specimens of the former remain long after the latter has entirely disappeared. This fact was reported independently by both Messrs. Brehme and Grossbeck and it accords well with my own experience. In New Jersey and especially north of the Shrewsbury River, *cantator* is without question the greater nuisance of the two. The early broods on the Elizabeth and Newark meadows are always *cantator*.

The common house-mosquito, *Culex pipiens*, has the singing habit most objectionably developed and makes every effort to get indoors. It seeks every crevice accidentally or intentionally left open, and even works through the meshes of wire screens. It is a typical indoor form and its flight is from early evening to early morning. It never voluntarily flies during the day, and rarely bites, even indoors. Its bite is to most persons, much worse than that of the salt marsh species, although of course there are exceptions to that. "*Pipiens* annoys me greatly and I would rather have a dozen *cantator* around than one of this species. It is not content to pierce the skin once and satisfy itself immediately with blood, but hovers over one, biting here, there and everywhere on the exposed or thinly clothed parts, and hardly ever alights heavily enough to be felt. Neither can it be located after it has ceased singing close to the ear, and is known to have settled somewhere in the vicinity. That it has settled and also bitten becomes evident when the insect leaves, which is soon after it alights and a burning, not stinging, sensation is felt. This burning continues an hour or more and is accompanied by a red, or in severe cases a white blotch. Half a dozen bites are sufficient to set one burning all over, and in my own case I prefer the heated rooms to the cool porch with that torture added."

'hile *pipiens* affects me badly I know that it is worse with others, where the burning lasts all night, and sets in again :xt night, after having cooled down during the intervening In some cases the blotches become as large as a copper ınd swell into veritable lumps. It has been said that *pipi*ıve some preference for the knuckles, and I do know that mosquitoes are abundant, one-half the number of blotches ›ncentrated on my wrists around the projecting end of the

. Grossbeck writes feelingly and, fortunately, the average dual does not suffer quite so much. Yet my experience is ıeral the same, and especially in the observation that a individual will move about from place to place and bite ıl times in succession without getting a meal. It has been cperience to have almost every knuckle on my hand punc- by one specimen and to find it, next morning, with scarcely than a trace of blood.

:re is every indication from the observations of the last two that *pipiens* will fly much further than we have been in- to believe, when conditions are favorable. Within city or limits the distance can probably be measured in hundreds :t. In the outskirts or open, and from virulent breeding it must be reckoned in as many thousands of feet.

'*ex restuans* has not been differentiated from *pipiens* in bit- ıbits. It is a breeder in cleaner water than its ally, and oc- nore often in the country than city districts. In sewer ; we have never found it.

'*ex sylvestris* is one of the commonest species next to those mentioned, and is a breeder in open swamp areas or even ›ols. It is rarely found in houses, tho at one time I sup- it was not uncommon and, personally, I have never been by a specimen, even when they were abundant round Until the present season Mr. Grossbeck's experience co- d with my own. "Recently I have been attacked in an ;wamp area by numbers of dwarfs. They bit very readily, along with me a short distance and alighting as soon as I :d. Their bite is in no way extraordinary and the effect l away with the mosquitoes."

'*ex perturbans* is another house mosquito, tho fortunately ed to very limited areas, owing to its breeding peculiarities. ı fierce and hard biter, a greater nuisance where it occurs ıny of its allies, and will get through any garment of ordi- thickness and texture in the effort to obtain blood. Its s very painful, but it does not usually raise a swelling and

the pain is not lasting. It does not sing and it is very fond — ankles.

Culex canadensis is the commonest of the woods mosquito and may be met with at most times throughout the summer, t most abundant in early spring. It is not aggressive and is rare seen, even when present in numbers, until one becomes qui Then a few may come along, hover some time over the point t be attacked, finally alight and timidly walk about seeking a favo able place to puncture. If not disturbed they finally bite, nc very severely, but are even then easily scared off.

Culex sub-cantans and *abfitchii,* the others of the common woods-mosquitoes are the *sollicitans* of the forest. "They mee you at the edge of the woods—for into the sunshine they rarel venture—and remain with you in buzzing, rather than hummin swarms, diving on to any spot that offers a chance for a punctur There they stay until satisfied, nor does the swarm leave unti you get out of the woods and into the sunshine." These mos quitoes never get into houses, but may become very troublesom in the evening on porches of houses near or in woodlands tha give them shelter. *Abserratus* has probably much the same habits.

Janthinosoma musica. "For persistence, tenacity and painful bite, this mosquito is approached in New Jersey by no species that I know of. It is with a feeling akin to pain that I look back on my experience in the Great Piece Meadows where, in fishing the transient pools for larvæ, several would be on each hand at once, besides a few more on the face. They come soaring with outspread legs and simply drop into place: there is no hovering over the point of attack. Large blotches were left wherever they bit and these remained for perhaps an hour; but there was no considerable after-effect. Most of the pain, which is extremely acute, is felt only when the mosquito is in the act of biting." Fortunately this species almost never enters houses and is rarely even found on porches.

Culex aurifer, in the viciousness of its attack and determination of purpose is a fair mate to *J. musica.* Its bite is not quite so painful, nor does the pain last so long; but in readiness it is the equal of any other species. Fortunately it is extremely local and has never been found in houses or on porches.

Culex pretans: "This is a ready biter, yet never in a special hurry to alight. It usually flies around until an exposed part is discovered, flies gently around this a few moments longer, alights and begins to puncture at once. It is one of the few woods mosquitoes that bothers me, producing the same burning

sensation that *pipiens* does. It gathers in numbers about the individual so long as he remains quietly in one spot, but does not follow in a swarm if he moves." Headquarters for this species is in the Great Piece Meadow and it attacks horses at least as readily as it does man. I think Mr. Grossbeck is rather exceptionally susceptible to this species, for out of a considerable party there present at one time none seemed to suffer as severely as he describes. In New Jersey this species is not an important one at present in any urban community known to me.

Culex trivittatus is a swamp and woods mosquito, and not usually abundant anywhere; but where it does occur, it attacks readily and bites promptly. In the woods the insects usually fly low and do not get to any exposed points. In an open swampy meadow Mr. Grossbeck found them more troublesome and, "while the individual bites were not particularly bad, their continued biting was extremely annoying." There was no notable after effect. This species is occasionally found on porches, but I have never known it to be found indoors.

Culex serratus and *C. sylvicola* are swampy woods mosquitoes and bite hard. But they are extremely local and usually very rare, so that little has been added to our previous knowledge of their habits.

Culex jamaicensis is a common dirty water mosquito, but not under ordinary circumstances a biter. In fact there is only one record of its biting at all. Mr. Grossbeck writes—"On this instance the mosquito bit just as darkness was coming on. I felt no pain at all at the time and calmly bottled the specimen; but pain developed soon afterward, with the same burning sensation that *pipiens* produces."

Of the other species of *Culex*, we know that *territans*, which is common enough throughout the State, does not bite. *Discolor, signifer dupreci,* and *melanurus* almost certainly belong to the same category. Of the others, referred to this genus, I can only say that they probably bite, but we have never met with them in numbers sufficient to learn definitely.

Psorophora ciliata, our giant species bites hard, but leaves no bad after-effect.

Of the species of *Anopheles,* all save one are house mosquitoes, singers and nasty biters. *Punctipennis* and *maculipennis* are very much alike in habit, both nocturnal and both sing in a deeper note than *pipiens*. The bite is equally painful but seems to produce a smaller swelling, more like a pimple than a blotch. The preliminaries to the attack are less elaborate than in *pipiens,* and the bite is usually prompt after alighting. *Punctipen-*

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nis is not known to carry malaria, is much the most common species in South Jersey, and has never been found in brackish water or on salt marshes. *Maculipennis* is more common northwardly, has been definitely proved a malaria transmitter, and breeds sparingly in slightly brackish water and on salt marshes.

Anopheles crucians occurs only in the southern sections of the pine belt, breeding along and on the salt marshes, and has not been proved a malaria transmitter. It bites as hard and is as anxious to get indoors as the preceding, but not so strictly nocturnal. It flies and bites and is an ugly porch mosquito in the Cape May district. In this connection it might be added that *Anopheles* species are easily screened out and cannot get through crevices as small as those that serve *pipiens*.

Anopheles barberi, is a woods mosquito purely, and we have no office records of its being a biter.

Aedes fuscus, Uranotaenia sapphirina, and *Wyeomyia smithii,* all have apparently well developed mouth parts, but do not bite mankind.

REPORT

OF THE

ENTOMOLOGICAL DEPARTMENT

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

JOHN B. SMITH, Sc.D.

FOR THE YEAR 1911

TRENTON, N. J.
STATE GAZETTE PUBLISHING CO., PRINTERS.
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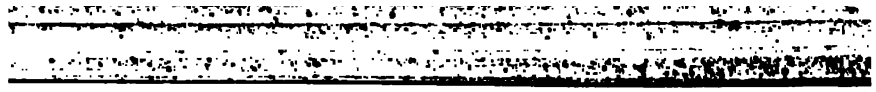

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It is not believed that there is a single living example of either of these species, at large, in any stage, anywhere in the State of New Jersey at the time of writing the above. During the summer there were more alarms than usual owing to the number of species that were mistaken for the pests; but every investigated case gave us a little additional assurance of safety, since it assured us a closer lookout and a broader general interest.

Of course, the area where the species was introduced in 1909-10 was kept under observation, and the New York authorities were, apparently, as greatly interested in the matter as we were. But besides our own men, I had Mr. Rogers assign one of his most reliable scouts onto the job, and his report to me was in all respects thorough and satisfactory. I feel absolutely certain that no slip took place here, and that the entire infestation, such as it was, was completely wiped out.

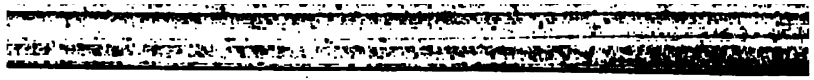
Nor do I feel that at any point where the insects had come in on nursery stock they have made their escape and have established themselves to any degree whatever.

At present, if any centre of infection exists, it is one that has never come to my attention at all, and it will be one in some altogether unlooked for or unexpected point.

And whether such an unlooked for or unexpected point will not be one due to a natural spread is at least a question.

Natural Spread.

This matter of natural spread in the New England States is of ever greater importance, and there is no doubt that, especially the Brown-tail moth, is so widely and so generally spread about that its



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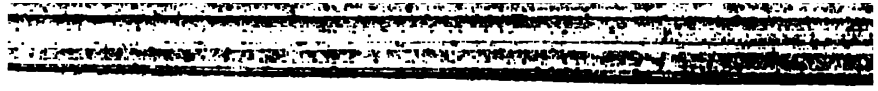

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It is not believed that there is a single living example of either of these species, at large, in any stage, anywhere in the State of New Jersey at the time of writing the above. During the summer there were more alarms than usual owing to the number of species that were mistaken for the pests; but every investigated case gave us a little additional assurance of safety, since it assured us a closer lookout and a broader general interest.

Of course, the area where the species was introduced in 1909-10 was kept under observation, and the New York authorities were, apparently, as greatly interested in the matter as we were. But besides our own men, I had Mr. Rogers assign one of his most reliable scouts onto the job, and his report to me was in all respects thorough and satisfactory. I feel absolutely certain that no slip took place here, and that the entire infestation, such as it was, was completely wiped out.

Nor do I feel that at any point where the insects had come in on nursery stock they have made their escape and have established themselves to any degree whatever.

At present, if any centre of infection exists, it is one that has never come to my attention at all, and it will be one in some altogether unlooked for or unexpected point.

And whether such an unlooked for or unexpected point will not be one due to a natural spread is at least a question.

Natural Spread.

This matter of natural spread in the New England States is of ever greater importance, and there is no doubt that, especially the Brown-tail moth, is so widely and so generally spread about that its

occurrence almost anywhere can hardly be looked upon as abnormal. In covering miles upon miles by auto, losing track of the species altogether for a time, picking it up again here and there in the most unexpected way, running across a few isolated examples, without reference to any others so far as information goes—all this gives an air of unexpectedness to the matter that would lead one to accept almost the most unexpected occurrence without any surprise. It has almost created a feeling of expectation that seems to await satisfaction, especially along the New York border.

Massachusetts Visit.

During my usual summer visit in 1911, in company with Mr. Rogers and Mr. Worthley, the chief impression that was given me was that of success—a conviction that the insects were under control. There was a feeling of confidence that, no matter what happened, the insects would not be permitted to get the better of the organization, and that the organization had all the necessary power to deal with the insects. There was not, however, any under-valuation of the force of the insects or any illusion as to their power to spread or cause injury. Simply the feeling of power that comes from a knowledge of the problem from all sides and a confidence in the ability to handle it.

It was perhaps the chief difference in the attitude of the office at large to the problem—less uncertainty and less helplessness even should the worst occur, and that, I believe, will, in itself, prevent any worst from occurring, because when the insect does seem to get beyond our control, it will be in seeming only, and there will be so many, many methods actually in use that there will be no real worst to come.

Bee Inspection.

Another piece of legislation that added to the burden of the Entomologist is the following, which forms chapter 60 of the laws of 1911:

CHAPTER 60.

LAWS OF 1911.

An Act to supplement an act entitled "An act to prevent the introduction into and the spread of injurious insects in New Jersey, to provide a method for compelling their destruction, to create the office of State Entomologist, to authorize inspection of nurseries and to provide for certificates of inspection," approved April fourteenth, one thousand nine hundred and three; to provide for the inspection of apiaries and for the suppression of contagious or infectious diseases among bees.

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. It shall be unlawful for any person, firm or corporation to have or keep in his or their possession or in any apiary, any colony of bees infested by the diseases known as American foul brood or European foul brood or by any other disease which is contagious on infectious in its nature and injurious to honey bees in their egg, larval, pupal or adult stages, and any person, firm or corporation so having in his or their keeping or in his or their possession any colony of bees so infested, after notice of the existence of such disease given as hereinafter provided, shall become and be subject to a penalty of twenty-five dollars, to be collected as hereinafter provided.

2. It shall be the duty of any person, firm or corporation in the State of New Jersey who is engaged in the rearing of queen-bees for sale, to have his or their apiary inspected at last twice during each summer, and it shall be unlawful to ship from such queen-rearing apiaries any package or parcel containing queen-bees without having attached to it a certificate from the State Entomologist, giving the date of the last inspection, and containing the statement that the apiary in which such queen-bees were reared was, at the time of such inspection, free from American or European foul brood, or other discoverable contagious or infectious disease. Any person violating the provisions of this section shall be liable to a penalty of fifty dollars, recoverable as hereinafter provided.

3. It shall be the duty of the State Entomologist, designated as provided in the act to which this is a supplement, by himself or by a deputy appointed as provided in said act, to investigate, or cause to be investigated, all apiaries or other places where bees are kept or raised in New Jersey, and to study and investigate, or cause to be studied and investigated, outbreaks of bee disease and other conditions unfavorable to the development of bees within the State. It shall also be the duty of said entomologist to investigate all complaints of the existence of disease of any kind in apiaries or other places where bees are kept, and to inspect or cause to be inspected at least twice in each season, when requested by the owner, all apiaries where queen-bees are reared for sale. It shall further be the duty of said State Entomologist, whenever he finds any apiary where queen-bees are raised free from foul brood or other discoverable infectious or contagious disease, to furnish the owner of such apiary with a certificate stating that fact, and such certificate shall state the date beyond which will not be effective.

4. Whenever in the course of the inspections or investigations made or carried on as provided in this act by the State Entomologist or under his direction, said State Entomologist shall become aware of the existence of

American or European foul brood or other infectious or contagious disease in any apiary or colony of bees, it shall be his duty to notify forthwith the owner or owners or manager of such infested or diseased apiary or colony, of the character of the infection and of the means to be taken to treat the same for the eradication of such disease. Said notice and order for treatment shall be in writing, and the directions for treatment may be written or printed, and may consist of a bulletin or other publication of the New Jersey State College Experiment Station. Said notice and order for treatment shall also specify the time within which the prescribed treatment must be made, which shall not be less than eight days after service of the notice or order upon the owner, owners or manager of the apiary or colony. And in case of doubt, where the presence of disease is suspected but cannot be definitely determined because of the character of the hives used, said State Entomologist may, in his discretion, order any owner of bees in box hives without movable frames, to transfer such bees to movable-frame hives to facilitate inspection and supervision. It shall thereupon be the duty of the owner, owners or manager upon whom such a notice and order is served, to comply with it in all respects within the time limited in said notice and order, and in case of a failure so to comply, such owner, owners or manager shall be liable to a penalty of twenty-five dollars, recoverable as hereinafter specified.

5. It shall be unlawful for any owner or other person having diseased bees or their larvæ, or infested hives or combs, or other appliances or utensils for keeping bees, to expose, sell, barter or give away or allow the same to be moved, until after treatment as prescribed by the State Entomologist, and it shall be unlawful to expose, sell, barter or give away such infested bees, larvæ, hives or combs or other appliances after treatment, until such materials are declared safe and permission is given by the State Entomologist or his deputy. Any person offending against the requirements and provisions of this section shall be liable to a penalty of fifty dollars.

6. In case the State Entomologist or his deputy shall find any apiary or colony of bees, in his opinion, so badly infested by American or European foul brood or other infectious or contagious disease that he shall deem it necessary to order the destruction of some or all of the hives, combs, bees, larvæ or other material as part of the treatment, and the owner, owners or manager of such infested apiary or colony shall dispute the diagnosis made by the State Entomologist or his deputy, or the necessity for the destruction of the hives, combs, bees, larvæ or other material, it shall be the privilege of such owner, owners or manager to appeal within three days after the service of the notice and order upon him or them, to the committee of appeal provided for in section twelve of the act to which this is a supplement, and the proceedings of such appeal shall be in all respects as provided in said section. Said committee of appeal shall have the same power to reverse, modify or confirm the order of the State Entomologist made under this act, that is conferred upon them in the act to which this is a supplement.

7. Any person who offends against the provisions of this act and becomes liable to the penalties prescribed in any of its sections shall be prosecuted as prescribed in section fifteen of the act to which this is a supplement, as amended by chapter forty-seven of the laws of one thousand nine hundred and four, approved March twenty-second, one thousand nine hundred and four, and if the order of the State Entomologist commanded the destruction of any bees, larvæ, hives or combs, or other utensils or material used in keeping bees, the judgment of the court imposing the fine shall include also an order to the officer enforcing its judgment to seize and destroy the specified colonies of bees,

arvæ, hives or combs or other utensils or material used in keeping bees, in accordance with said order, which the said officer shall thereupon be fully authorized to do.

8. For the purpose of making the investigations and inspections specified in his act and to enforce the provisions of the same, the State Entomologist or is deputy shall have free entry upon or into any apiaries or premises where ees are kept, or infested hives or combs are stored, and any interference with r obstruction made to the entomologist or his deputy while engaged in the performance of the duties herein imposed shall subject the offender to punishment s a disorderly person under the general laws of the State, upon a charge ade against him by the officer interfered with.

9. The sum of two thousand dollars annually is hereby appropriated to the tate Board of Agriculture for the purposes of this supplementary act; *provided*, that no payment shall be made pursuant to this supplementary act until he amount thereof shall have been included in the annual appropriation bill.

10. This act shall take effect immediately.

Approved March 28, 1911.

The Committee on Appeal, appointed by the Executive Committee, is Franklin Dye, Secretary of the Board; Mr. Elias Black, of Little Silver, a member of the Board and of the State Board of Horticulture, and Mr. Albert S. Repp, a member of both boards and of the Executive Committee of the State Board of Agriculture.

The bee legislation was the outcome of a long series of attempts by the bee-keepers of the State to control the spread of foul brood; but heretofore the attempt has been made outside the organized Agricultural Societies, and has been open to the suspicion that there have been selfish motives back of it. By turning the whole matter over to the State Board of Agriculture, with the remainder of the Entomological Inspection work, this subject was put on a proper basis and no serious opposition was encountered.

The bill carries an appropriation of $2,000, and $1,000 was made available for the fiscal year ending October 31st, 1911. Under the Civil Service law, Mr. Charles S. Sharp, of Newark, New Jersey, was appointed deputy July 1st, 1911, and served for the balance of the year, when he resigned to accept a better commercial position.

During the three months of his service the information secured justified the inspectorship in every way. There is scarcely a locality in which foul brood, European or American, was not found, and no point where bee-keepers were not in need of information and assistance. It is probably too much to say that New Jersey is in worse condition, so far as its bee industry is concerned, than surrounding states; but it is certainly in no better shape and

needs all the assistance that the State can give under the legislation already enacted, heartily backed by its organizations, to maintain the commercial industry and the natural advantage that the bees offer our horticulture. This is a topic that is bound to become important, from the horticultural standpoint, and that must become somewhat prominent in our short courses and farmers' institute work. It is on the State side that it will require most attention then and where details of conditions found will be recorded.

Cut Worms.

With so large a variety of cover crops, and so many trucking plants, the matter of cut worms will always be an important one in our State, and not always the same for several years in succession. This year, for instance, cover crops, like clovers and alfalfa, have suffered out of all proportion to conditions in previous years, while the truck crops, that have in some other seasons found reason for serious complaints, have hardly been reported on the troublesome list. It has been the late fall list, in fact, that has been the source of trouble in 1911 rather than the spring list. Something we must expect to bear each year with more or less philosophy, for almost invariably something must be neglected. Late injury to alfalfa is one of those things that as a rule can be borne since no permanent harm is done and only a temporary feeding on a certain amount of forage is suffered. It is not always realized that this late feeding is not always dead loss either, because there is nearly at all times concealed with the source of trouble the parasite or source of remedy for it. It has been so in almost every case investigated by us this fall.

Insecticides.

Practically nothing was done with insecticides during the year just passed that I am in condition to report upon just now. A very large number of experiments were made by Mr. Weiss in the course of his greenhouse work at Riverton; but this was planned on a large scale and should be reported upon in a comprehensive manner.

During the several years last past that I have been engaged in the work of inspecting greenhouses, not only in the State of New Jer-

sey, I have come gradually to the realization of the fact that the bulk of all the work that is done indoors, under glass, for the destruction of injurious insects is wasted and might as well be thrown away altogether. Much of the work done in nurseries is of the same character and there appears to be a perfectly enormous field practically new and almost virgin in its character.

In selecting Mr. Weiss as my assistant in the work of the State Entomologist in New Jersey, I kept in mind this feature, and one of his main qualifications originally was a knowledge of chemistry that would help in this line rather than the more general inspection work that he was later called upon to undertake. However, for a period of several months Mr. Weiss spent his time in the greenhouses very largely; in collecting and familiarizing himself with the foreign and other species to be dealt with and in becoming in all respects fully acquainted with what may be called current nursery practice against usual nursery pests. He is therefore fully up to date on these points, and has reported in considerable detail the practice and effect in perhaps the majority of State practice.

This forms a bulk of material to draw upon for further experimental work that is really not yet open and will form a foundation for the most valuable kind of work ever done in the Eastern United States, so far as greenhouse work is concerned.

Room for hap-hazard experiments there was none in this scheme, and therefore whatever insecticides have come to us have been classified and arranged for such use as might seem indicated in the general work to be carried on.

Field work has not been done to any considerable extent with insecticides. The character of the work laid out has been against it and the opportunities have been against it. It is no part of the Experiment Station work merely to try out materials for the benefit of manufacturers, particularly when there is no certainty that these materials will be put on the market afterward or maintained at a standard at which they are tried. Therefore, a recognized chemical commercial combination, like arsenate of iron, is a legitimate material for experiment, but Smith's carbolic destroyer is not, although, as a matter of fact, the latter may be a very useful sort of material indeed for a limited purpose or a temporary difficulty.

Strawberry Weevil.

This insect found the season much to its liking and was extremely troublesome, not only in the territory heretofore covered by it, but much further north; extending into Burlington, Gloucester and Camden counties. Even the wild strawberry plants at Vineland were found to be infested and scarcely a field escaped trouble of some kind.

Up to the present time the growers do not seem to be inclined to modify their practice or to select varieties not subject to attack, preferring rather to stand the injury and hope for better things in the future.

Mr. Blake, in the Horticultural Department, however, expects to take up the matter from this point of view in the hope of securing varieties that will be satisfactory as to crop and quality as well as resistance to these insects. Nothing new has developed in the way of a practical method of destroying the insects or avoiding damage.

Asparagus Beetles.

Both species were very much in evidence early in the season, and in the more southern parts of the State in approximately equal numbers. Further to the north the older species (*C. asparagi*) was much the more abundant and, north of the red shale line, the only species. It was interesting to find that greater injury than ever before was reported from the most northern points which had, in the past, suffered but little.

The growers in Monmouth, Burlington and other southern counties have learnt pretty generally that the arsenate of lead, carefully and thoroughly applied after the cutting season is over, is a reliable and effective check to both the species, and that little injury need be suffered where the application is made before the first brood of larvæ gets much of a start. One pound to 10 or 15 gallons of water, depending on the strength of the arsenate, is recommended.

Harlequin Cabbage Bug.

It is many years since there was opportunity to record this species from New Jersey, and even now it is sent in only by Mrs. E. S. Starr from the vicinity of Ocean View in Cape May county, as if it didn't really belong there.

As a matter of fact the only time that the insect really did get a good foothold in the State was in 1906, and that occurrence was recorded in Bulletin No. 121 of the Experiment Station. It disappeared almost or quite completely since that time and certainly has not again re-appeared as an injurious form.

Plant Lice.

Plant lice were not much complained of during the season, and that was especially true of those infesting trees; but in midsummer some complaint came from Burlington county, where it was said hundreds of acres of tomatoes were infested in early July. Mr. Weiss was assigned to the field with instructions to find whether other Solanaceous families also shared in the attack.

Mr. Weiss began his investigations at Moorestown on July 11th, and found that the lice began to be prominent on tomatoes about the first of that month, increasing very rapidly on all plants of the Solanaceous families until about the 8th, when these seemed to be literally millions of them on hundreds of acres, chiefly on tomatoes.

At about the time they seemed most threatening, however, some adverse condition seems to have intervened, and conditions now seem almost as favorable as ever for the plants. There were still plenty of plant lice, but most of them were dead or dying, drying up on the vines; with numerous parasitic and predatory foes of various descriptions among them and rapidly reducing them in number.

The Garden Web-Worm.

Eurycreon rantalis.

This is an insect that once upon a time played tricks in a great many of the Central and more Southern States, and under its common name of "the garden web-worm" obtained rather an unpleasant reputation. In New Jersey it was rarely found and practically not at all troublesome. So little, in fact, that I did not have it represented in my series of injurious forms, and did not recognize it when it was sent in during September as appearing suddenly in great numbers in an alfalfa field at Center Square.

I sent at once to Center Square on September 19th, and Mr. Patterson reported that the full grown caterpillars as present, not only in considerable numbers feeding upon the alfalfa, but also upon lima beans, and that for twenty feet the lima beans had been as completely destroyed as the alfalfa. Clover in a nearby orchard had not been attacked, nor had other alfalfa plants in the immediate vicinity; but throughout the alfalfa field in general there was quite an infestation, and at one end the plants had been almost defoliated.

At the time that the investigation was made the caterpillars were active, vigorous, just about full grown, were busily engaged in spinning their webs, and their general character as a *Pyralid* and a member of the Botid group was sufficiently obvious. Yet somehow or other the insect did not thrust itself upon my remembrance, and it was allowed to go into the breeding jar and into the pupal stage without being recognized. During the middle of October, when an adult was bred the recognition was immediate, and the comedy of errors was at an end.

There is no species involved here that has suddenly adapted itself to feeding upon alfalfa, but simply this miserable garden web-worm has added one more to its ordinary range of food plants, which it will take in whenever it becomes abundant for any reason.

It is very curious that this should have been the only case of this kind that has occurred within the State up to the present time of an attack upon alfalfa by so well known a general feeder, or by cut-worms in a general way. So vigorous a grower and so attractive a plant would seem scarcely likely to escape an attack of this

character. I must confess, however, that the attack by this garden web-worm was altogether unexpected, and looks like a good deal of an absurdity.

Blister Beetles.

Blister beetles or *Meloids* are comparatively few in number in the Eastern United States so far as species are concerned, although some of them are very numerous in specimens; the latter occurring chiefly late in the season and being of types such as those known as the old fashioned potato beetle, and some of those species that are found on late blossoming flowers in the gardens. In the far west the number of species is abundant as well as the number of specimens, but the insects there form a distinct feature of the beetle fauna of the country.

It very rarely happens that a few of the species that occur with us in the early part of the season occur in large numbers, and when that does occur it is usually a matter of only a day or two, and a matter of very large numbers.

The season of 1911 was one of those when species of this character were common, and not only in the State of New Jersey but also in the neighboring States of New York and Pennsylvania flights occurred of species of *Pomphopœa,* which for a day or two entirely covered peach orchards, and seemed for the time being to threaten the crop itself; but in every instance the invasion seemed to have lasted for a single day only, and the specimens that were sent in by the correspondent with the first communication were all that could be obtained. Invariably a letter sent by return mail and asking for additional specimens was answered by the statement that the insects had completely disappeared, and that no more of them could be found. It is a curious fact that this is one of the group of species where it appears as if all the insects of an entire brood came to maturity on identically the same day, and exactly the same conditions seemed to bring them all out at one time. They make their appearance, get their food supply, mate and lay their eggs and disappear—all within forty-eight hours—coming like a nightmare and causing a threat that is never carried out. We have in our local fauna just two species which make their appearance under conditions of that kind. The others are more or less annual visitants, in smaller numbers.

The Bramble-Flea Louse.

Trioza tripunctata Fitch.

This is one of those species which the collector seem common enough in winter on pine trees, and which seems in summer on deciduous plants of an altogether different

As far back as 1869 it was found troublesome in Ne by Mr. Charles Parry, of Cinnaminson, on blackberry, Mr. A. S. Fuller, in 1880, read a paper on the insect b New Jersey State Horticultural Society. Mrs. Mary Vineland, also in New Jersey, described the species in 1 Dr. Riley wrote concerning it in the American Entomolo

Heretofore it was always in New Jersey, and on the b that the insect had been troublesome; but in 1893 M Sirrine found it injurious on Long Island, and wrote concerning it in the Report of the Entomologist of the N Agricultural Experiment Station. He wrote a brief a the egg-laying habits and something concerning the inju on the vines, and he gave a suggestion as to how the trou be avoided.

In 1910, Mr. George W. Blodgett, writing from Lakev a badly distorted blackberry shoot, with a request for in which there was nothing at the time on the specimen to to give him.

June 15th, 1911, another sample of distorted blackbe was sent in; it was determined that this was probably origin, and Mr. E. L. Dickerson was assigned to visit th June 23d. He found them in the heart of the pines, t ends of a few rows in a clearing, and that the upper a shoots of almost every plant were distorted and twisted semblance of normal growth. The extent of infestation what greater than it was in 1910, but there is no record infestation. The old injured canes had become complet around and had masses of dry leaves attached to them.

An examination of the collected material showed numb characteristic eggs attached to the curled hairs and, to son on the upper as well as the underside. In some of t leaves recently hatched nymphs were also noted, but on

Figure 1.

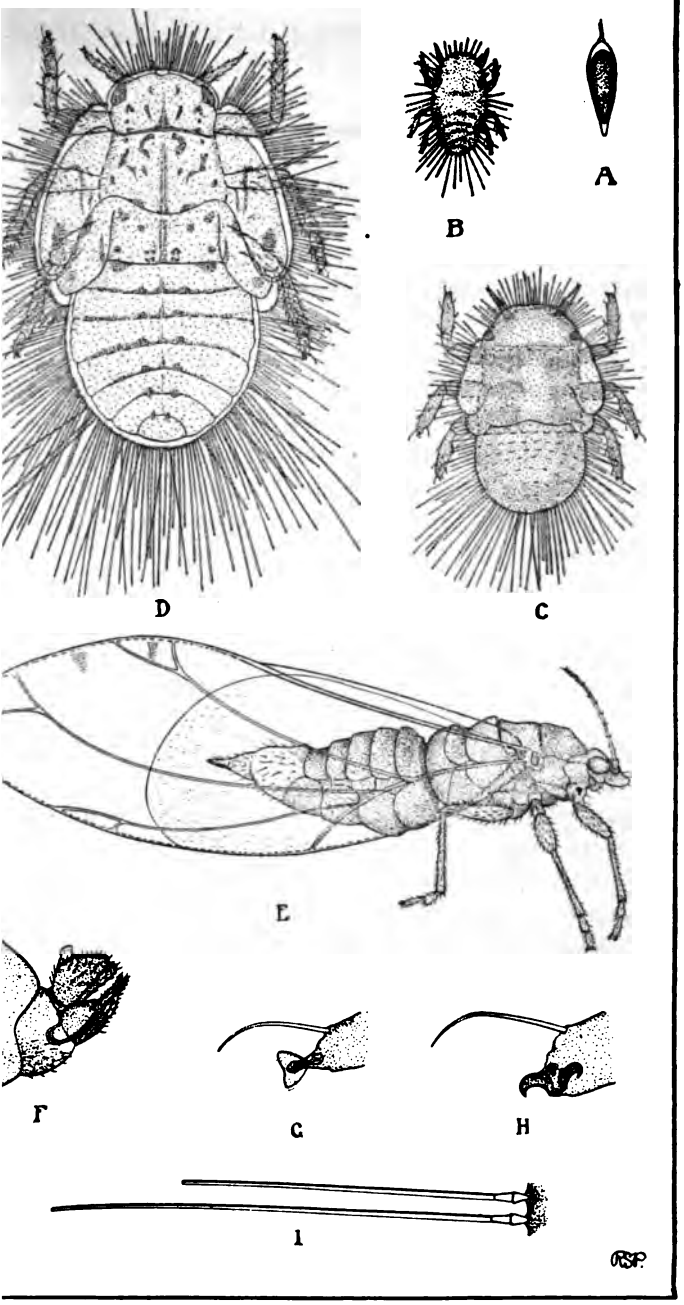

Figure 2.

Bramble Flea Louse. *Trioza tripunctata.* Fitch.

ou peduncle.
t Nymphal stage, found June 23d.
ond Nymphal stage.
rd and last Nymphal stage.
lt, female, found September 25th.
talia of male.
of leg of first Nymphal stage, showing sucker disk.
of leg in second and third stages, showing claws.
hairs from Nymphs, showing the secretary glands. **All greatly magnified.**

adults were seen. In any event there was no further doubt as to the character of the species that we had in hand.

July 19th, Mr. Dickerson was again at Lakewood and found conditions very little changed. There had been no obvious spread to new plants and the infested plants were not much worse off. On some canes the shoots were shorter and more bunched and more infestation was noted in those curled leaves. At the growing end and upper part of the infested canes some of the leaves, especially on the underside of the curved or infested canes, were more or less curled and developing abnormally. But at the tips or on the upper parts of the canes I could find little or nothing in the way of infestation. There were no adults on the vines at this time, and the adults developed in the laboratory very slowly.

All the insects were in the early stages and all had the jointed, waxy threads that are so readily broken off and give the surface of the leaf its characteristic powdery material appearance.

Now, here the office observations are incomplete and unsatisfactory. Mr. Dickerson collected the insects and should have kept them under observation; but he was getting ready to leave, was closing up his notes and workings and was finishing up the inspection work. I ought to have taken charge and assigned his work; but my own illness kept me away from the laboratory for a month continuously, and Mr. Patterson was simply instructed to make drawings.

We have no records therefore of the length of time during which the insects remain in the various stages except that growth is very slow, that the adults do not appear until September, and we do not know why or under what conditions they go to the Pines.

As to the character of the injury caused, Mr. Dickerson writes: "The curling of the uninfested leaves I believe to be due to something other than the direct injury of the insect. It may be that the tissues of the infested and curled canes were so poisoned by the early feeding of the adults that these canes cannot get the proper nutrition nor mature properly. It is to be noted that the distorted and malformed leaves come on the upper part of the cane or on the underside. I cut open some of these curled canes, but could find no evident injury to the tissue.

Remedial Measures.

As the adults obviously come on the blackberry vines early and cause their distortion by feeding before laying their eggs, injury to the endangered plants can be prevented by spraying with kerosene emulsion as soon as the first adults are seen.

If this is not done it will be possible to wait until all the eggs are laid, and about the time they are beginning to hatch, cut back to sound wood and destroy all trace of malformation or of the area where eggs are laid. The entire subject is so characteristic and peculiar a one that it does not seem possible that it can ever be of wide-spread importance.

Apple-Leaf-Hopper.

Empoasca mali Le B.

This leaf-hopper again made its appearance in the Barclay orchard near Cranbury in destructive numbers, and in some other places in the vicinity in somewhat smaller quantities. It is always rather plentiful as a matter of fact, and the discolorations on the leaves of the younger trees after mid-summer always indicate the presence of a considerable crop of them; yet it is rather exceptional to find any real impairment of the crop due to the feeding.

Mr. Dickerson was with Mr. Blake on the Barclay orchards, June 8th, and there was no doubt of the impairment of the vitality of the foliage in spite of the spraying that had been done. Egg punctures were also found in some numbers, but the eggs seemed in poor condition, and few of those brought into the laboratory developed normally. One pound of fish-oil soap in 8 to 9 gallons of water had been used, and there is no doubt a good result was obtained; for later in the season the insects were materially reduced and did not, in September, when I saw the orchard, make a bad showing in it.

On several occasions during the summer I had opportunity to observe accumulations of these leaf-hoppers, and there is no doubt in my mind that the amount of injury actually caused by them is scarcely appreciated. This applies not only to the particular species here under consideration; but to leaf-hoppers in general.

Apple Bud Moth.

This is not a species which under ordinary circumstances is troublesome in the State of New Jersey, and is not one against which applications are usually recommended. It makes its appearance quite early in the season, and where it does occur often causes a great deal of injury to the fruit crop. For the first time reports were brought in this year by E. W. Stafford and by Edgar L. Dickerson of bud moth injury at Trenton and High Bridge in the apple orchards at those points. The insects were not abundant at either place; but they were quite noticeable and enough of them were collected to make certain of the species, and to determine the fact that the insect was really a factor in our orchards, and might, under certain circumstances, become a dangerous one. It behooves apple growers to keep a lookout for the species, and if anything more is noted concerning it in other years to bring the matter to the attention of the Station, so that such investigations as may be indicated may be made and the New Jersey practice determined upon. It is hardly likely that the insect is apt to be as dangerous and as injurious as it is in some of the more northern orchards.

The Common Plant Bugs.

Capsidæ species.

Not a factor of the species that the Entomologist sees on the plants that come under his observation during the summer does he pay more than the slightest or most cursory attention to. He may and often does realize an interesting life history slipping away from him here and there; but he realizes that the number of such happenings is out of all proportion to his ability to attend to them and that very frequently an entire group of species may take part in an attack or a series of attacks that would require years to work out.

So is that series carried on by the so-called Capsidæ or common plant bugs, species in which some entrance has been made of recent years and which have in common the puncturing of the leaf and fruit tissue of apple and allied fruits, and the resultant injuries from either egg-laying or feeding punctures at one or more stages of growth.

Figure 3.

False Red Bug; its work in New Jersey Apple Orchards; enlarged. From original Photo by Mr. Blake.

Quite a variety of species of Capsidæ have been brought in by he field agents and by Mr. Blake and his assistants, and in every nstance where there has been any observation or study made there as been that tendency to dimpling and to the puncturing of the issue resulting in the distortion and injury. The relationship is ot always so entirely simple either; because in many cases there ay be more than one economic species involved and a dependence pon a small fruit in one stage does not always nor altogether pre-ent a dependence upon a large one in another.

The False Apple Red Bug.

Lygidea mendax Reut.

During the summer of 1911 Mr. Blake brought in from time to me some peculiarly knotty apples, and others, of the office force bserved and recorded similar specimens from various portions of ew Jersey. Bulletin No. 291 of the Cornell University, issued 1 January, 1911, identified these abnormities as due to the ork of "Apple Red Bugs," and, later in the season when speci-ens of the insects as well as their work were collected by Messrs. tafford and Dickerson at the College Farm, at High Bridge, at ridgeton and in other sections of the State, it was possible to entify with certainty the "false" red bug, as the true species at ult in our State.

In New York there are apparently two species at fault; similar size and color, very much alike in general life history and yet fficiently unlike in all stages and in development to be easily dis-nguishable at all times. Thus far only the somewhat smaller, ther more slender and less punctured form has been found in ew Jersey, and that is the one to which the term "false" red g has been applied, although it is as uniformly bright tomato d as the other species.

The winter is passed on the trees in the egg stage concealed in e bark tissue, and the young or nymphs are hatched in the early ring very soon after the trees make a start. The young, as all true bugs, puncture the leaf tissue and cause distortion as ell as discoloration; the distortion often taking the form of isting or curling which serves as a concealment to the insect.

Like most of the true plant bugs these "red bugs" are active, light on their feet, very elusive and difficult to capture. Even when there are a number of specimens present and even when they are not winged they are nevertheless difficult to capture and are not even readily seen by one who does not know pretty nearly what to look for.

The injury caused on the foliage seems to be rather a minor matter thus far in our State; but the injury to the fruit is more serious. The young apple also is punctured for food, and wherever a feeding puncture is made a check in growth results. The outcome is, on some varieties at least, a collection of curious freaks of little or no commercial value, a drain on the trees, even if not a direct menace to them.

Nowhere have we found the insect harmful enough as yet to require practical treatment; but it seems to have become important enough in New York, and the New Jersey grower should be on the lookout ready to deal with the insect at the beginning. It requires about five weeks to come to maturity and spends most of the season in the bark tissue in the egg stage; but during the five weeks of early season it is capable of considerable injury that will hang through the balance of the season.

As to remedial measures it is hardly worth while going into details as yet before we know definitely whether one or both species will have to be dealt with. It will, apparently, require the addition of a tobacco extract to our spring battery, and that would mean a material advance in cost.

Pear Midge.

After so bizarre and abnormal an appearance as this insect made at New Brunswick last year some sort of abnormity might not unreasonably have been expected during the season of 1911. But on the contrary the insect was almost completely absent. I never had so full a crop of Vermont Beauty Pears which came to entire perfection and with scarcely a trace of the insect at any part of the season. At the College Farm Mr. Blake reported a few specimens of Seckle infested and that was all. The insect just barely maintains itself in an aggravating way that makes it impossible to adopt any systematic measures against it; because one never knows where the next attack is to be repulsed nor what

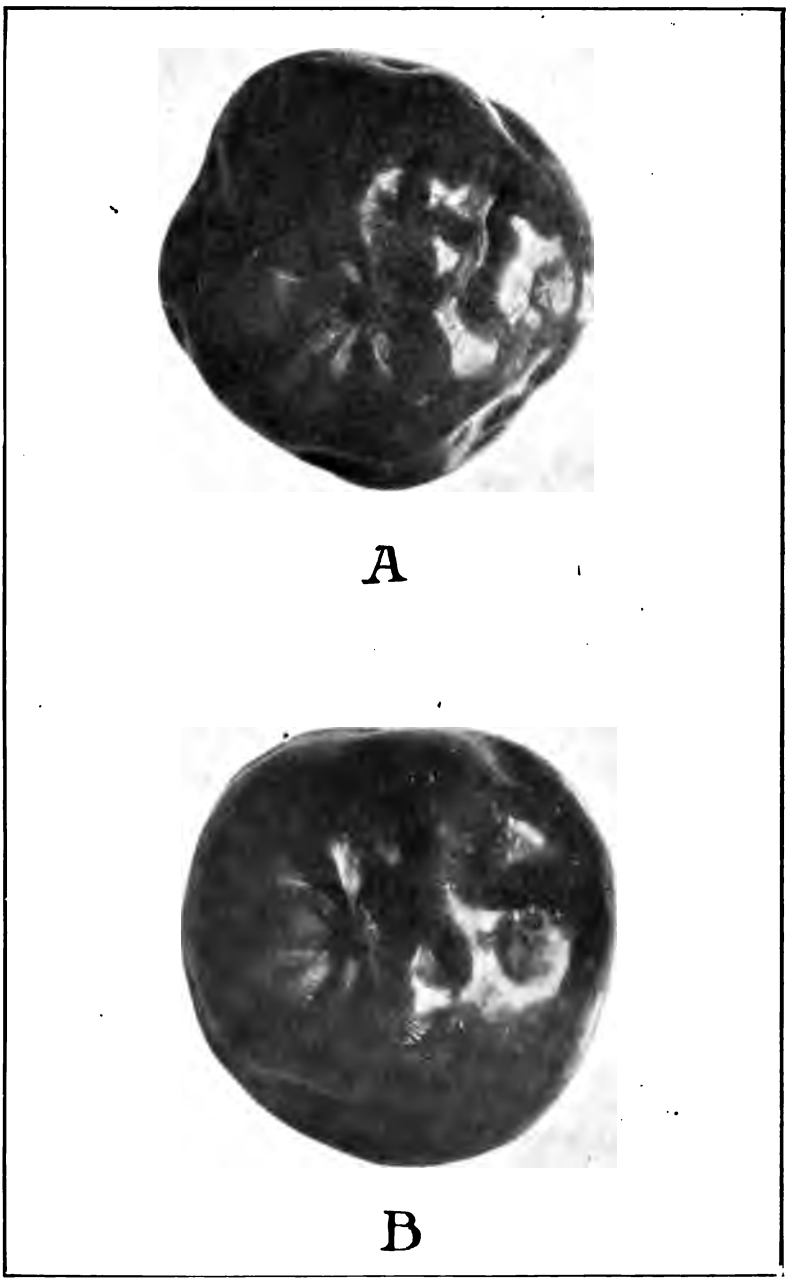

Figure 4.
Injury to apple fruit from the false red bug.

ature is going to do. An attitude of expectation is therefore ıe only possible one, with such measures of relief as are permitted ıch year by the nature of the infestation.

Pear Psylla.

It is rare nowadays that reports of injury from this insect are ·ceived, because almost every pear grower knows it and knows ow to deal with it as soon as it makes its appearance in his or-ıard. It is only when it seems to make its appearance in a new ·eality or to attack a new variety that it attracts attention, and ıat samples are sent in in order to make certain of the nature of ıe attack.

Thus, for the first time in many years, specimens of the in-·ets were received during the summer from Atlantic county vith the report that they were attacking the Koonze pear. This vas rather a new habit for the insect, and the grower wished to ıake certain that he had only an old friend or enemy to deal with ·fore taking the necessary steps in the matter. It seems that here is almost no variety that is entirely exempt from the attacks ·f this insect, and that we have got to keep a lookout for it on ·ractically every variety that is grown.

The Maple Pseudococcus or False Scale.

This insect has attracted attention throughout the State and as been perhaps the one most generally reported on shade trees utside of the elm leaf beetle. Both the leaf form and the trunk orm have been complained of, and on the whole the leaf form has een found more abundant and has been more frequently referred) than the trunk form.

When the insect made its first appearance in the State a few ears ago, the trunks of the trees became so covered that they ap-·ared to be whitewashed, and in some instances thick accumula-ions of cottony material were found on the surface. This form f infestation seems to be less abundant at the present time; ut there seems to be more complaint of infestation on the under-ide of the leaf and the consequent dropping of the leaves in the arly part of the season after a premature ripening.

This is one of those insects that is best dealt with in winter so far as the trunk form is concerned, and so far as the leaf form is concerned is best dealt with as the leaves drop. The infested leaves tend to become lifeless, especially during a droughty spell in middle or late summer and then drop to the ground. If they are kept raked up and burnt, the insects will be, of course, destroyed, and there will be nothing to go through the winter. The recommendation has been made that in cities and towns the trunk form can be kept in check by the use of the solid jet on the trunks, using the ordinary water pressure, and this recommendation is a good one. During the winter these insects are particularly exposed to the effects of the miscible oils, because they hibernate in the crevices of the bark and in the lower parts of the tree trunks. Even strong solutions can be used there without danger to the tree and with good effect against the insects. In fact, for ordinary city trees this particular species ought not to offer any serious difficulties whatever.

Oyster-Shell Bark-Louse.

Lepidosaphis ulmi Schimer.

It is actually a fact that this common native species is again replacing the San José or pernicious scale as the form most frequently received by the Entomologist with request for information. It is not, as a matter of fact, more abundant than it ever was; but the relative disappearance of the pernicious scale from the garden and shade tree field has restored this form to so much of its old time importance that it attracts more attention.

It is really the most common of the species sent in at the present time and the one demanding the greatest amount of information from correspondents. In a way it is really not so easily dealt with as the San José Scale because that could be dealt with at practically all times during the winter.

The oyster bark scale cannot be dealt with during the winter, but does give an excellent opportunity to look over many a nasty jungle during late winter and clean and trim out a mess that ought never to be allowed to go along into June.

In any reasonably well-kept orchard the oyster-shell bark-louse will keep itself in fair condition without especial attention. In

carelessly kept garden the scale on willow, poplar, lilac and ilar plants will run itself to a stage when it threatens the its it primarily infests and its surroundings. It is always a at to maple and elm and has a large range of food plants to ch it may be dangerous than any other except the pernicious e.

wide range of excursions by allied species into greenhouse its has been investigated by Mr. Weiss, but forms a distinct ure of study.

The San José Scale.

There are a great many persons in the State of New Jersey believe that this insect is a back number and one that needs e or no more attention. There are a few persons who did e that belief, who know emphatically that it is a living issue, that it is a species that needs the most careful attention. re are others who know that both of these statements are lly and approximately true, and that he who runs carefully works cautiously will come nearest to being right.

In the course of our nursery inspections we hit every part of State, every variety of growth, and every condition under ch plants are grown and almost everywhere orchard stock in nection with the nursery stock. The judgment formed in this rk therefore may be considered in general well based for the ite, and we do not by any means consider the scale a negligible tor. That it is no longer the virulent pest of ten or a dozen ars ago is true in most cases, but I would not trust the species ywhere where it seemed to have a good hold and a healthy start. also as it seemed late in starting in the hills of North Jersey ong the apple trees, it seems first to lose its hold there.

Apple buyers who have been over the crop carefully with the ect of storing for winter, report orchards free from infestation t were not worth buying three or four years ago, and without atment of any kind.

On the other hand, growers who found so little scale in their hard this spring that they concluded to risk without application insecticides, find their crops at harvest so badly infested as to almost unsalable.

My advice in all cases is to watch the insects closely. With the miscible oils and the commercial lime and sulphur mixtures we have so strong a hold on the species that we can check it with much greater certainty than ever before, and it has lost its old terrors which seemed to be based on the idea that we were practically helpless as against it.

The worst section of the State is perhaps the Delaware river section of Burlington county, and the scale is perhaps more flourishing there than almost anywhere else.

In our nurseries it has been almost completely eradicated, so that most growers prefer to destroy the few infested plants rather than treat them. No honest man has an excuse nowadays for selling an infested plant, and no one is in the position to do so ignorantly.

As for remedial measures nothing has been added to our batteries. Scalecide and other miscible oils are still recommended and used, except where the lime and sulphur combinations have especially approved themselves.

A New Clover Weevil.

Mr. E. G. Titus, who has been studying the species of the genus *Phytonomus*, which includes the common clover leaf beetle and also the newly introduced alfalfa weevil, reports that among the material received by him from New Jersey there occurred specimens of the European species *Phytonomus melus* Fabr.

This pest feeds on red clover and was bred on that plant at Albany, New York, by the State Entomologist, Dr. E. P. Felt. In New Jersey it has been found at Ramsey, Hewitt, Lake Hopatcong, Newfoundland and Rahway, from late May to the end of July. Specimens are reported also from Connecticut and Massachusetts, and it is certain that the species has been with us for a number of years and has become widely distributed. Whether it will graduate into a serious pest is yet a question.

Mr. E. A. Bischoff, of Newark, has found it in some numbers at Springfield, during the present season, so that a continued increase may be expected.

Shade Tree Insects.

There were not so many inquiries concerning these insects as usual when the gamut of species is considered as a whole; indeed the shade tree commissions as a whole did a great deal of their work outside of that with elms and maples by digging out the facts themselves and thus getting first hand information except in the case of borers. These proved troublesome all over the State, and on quite a large range of trees. Less indeed in the case of the large species like the wood-leopard moth which might have been supposed to give most difficulty than in the case of the maple and hickory species which appeared in more isolated numbers and in more scattered localities throughout the State.

It is an interesting and encouraging feature that tree owners are exercising a great deal more interest in this kind of property and are actually realizing that attention to it pays.

The organization under the auspices of the State Forester of a State organization and the appointment of a State Plant Pathologist, cannot but help forward and favor the case of and an interest in shade trees.

The Poplar Leaf Beetle.

Melasoma scripta Fab.

Throughout the State on young trees of willow, poplar, and to a less extent on elm, and particularly in nurseries, the larvæ of this beetle have been unusually abundant and injurious. In some nurseries the insects were so abundant that it was necessary to spray in order to prevent complete defoliation, and in some places, where poplars were recently set out, the young trees were completely defoliated and seriously injured. Willows were much less injured and older trees were in general attacked while elms received incidental attention only. This is a species that is always more or less abundant in some sections of the State on young nursery trees; but which rarely makes its way beyond nursery confines. Weather conditions in the early part of the season seemed particularly favorable, however, and the beetles found it possible to pupate and produce maximum broods. It was only

prior to mid-summer, however, that the insects were abundant or troublesome, and later on their parasites and other natural enemies brought them down to their normal harmless condition.

The Mourning Cloak Butterfly.

Vanessa antiopa Linn.

It is not often that a true butterfly becomes injurious in this State; but this common Mourning Cloak Butterfly certainly was abundant enough to attract attention during the early days of the season on elm trees, and it was not so much that it was injurious in itself and attracted attention by its spiny character and appearance, but it was quite generally mistaken for the caterpillar of the Gypsy Moth, and it was sent in on several occasions for that insect from different parts of the State. I found it myself at New Brunswick in localities where, under ordinary circumstances, the caterpillar is rare. It was brought in by correspondents to the office, and sent in from almost every portion of the State, so that the conditions that favored its increase were not local but statewide. There had been no unusual hibernation of adults, because I would have noticed that, or it would have been brought to my attention, and there seemed to be no unusual increase in the size of the butterfly brood that made its appearance in mid-summer. There was simply a large increase in the first brood of caterpillars, which was abnormal, which attracted attention and which disappeared without leaving a trace later on. It was only on elms that the insects made their appearance, and none of the other normal food plants seemed to be unduly attacked.

The Cotton Moth.

Alabama argilacea Hbn.

A curious and interesting occurrence in late September and early October were the flights of swarms of the Cotton Moth which came into New Jersey and adjoining States, and were observed at the lights of various cities and towns in greater or less numbers. I found an example of the moths, in perfect condition,

on a hedge in my front garden at New Brunswick; examples were sent in from the most northern towns, they were reported in enormous quantities at Atlantic City, and examples came in to me, for determination, from Connecticut.

Of course, these insects created uneasiness for which there was no justification, for their presence was purely as adult migrants incapable of feeding or other injury. But it did indicate a condition in the Southern or Cotton States that favored the development of a terrific brood, and the consequent serious injury to the foliage of the plants whether generally or of one particular district only.

The European Hornet.

A few years ago occasional specimens of the European hornet (*Vespa crabro*) were found in the vicinity of New York City and in New Jersey, and some good nests were found by New York Entomologists and figured. Since that time the insects have spread in New Jersey and are beginning to be a nuisance.

They are much larger than our own white-faced wasp or hornet and much more aggressive. They build their nests usually in concealment in hollow trees, or in attics or in shelters of that general character. Small colonies will get into bird houses or other similar places and will fill them with their paper nests. While the nests are somewhat similar in character to those made by our common paper wasp, they are not nearly so tough and do not stand the weather as well. They are more brittle, more rotten and go to pieces much more easily.

The workers have a fashion of girdling the plants from which they gather their wood fiber, and lilacs are among the favored plants from which fibre is gathered. Furthermore, the hornets are great fruit eaters, and will chew into apples, pears and other fruits, particularly when they are just a trifle over-ripened. They become most offensive in September, and have now extended almost throughout the State, specimens having been sent in from the heart of the pines in South Jersey, as well as from almost the northernmost county of the State.

Routine Work.

The usual routine work of the department has been continued in the way of attendance on meetings of various kinds, scientific and formal, and addresses have been prepared and delivered before various agricultural and scientific bodies. Not the least influence now wielded by the office comes in this way, and it requires an ever increasing amount of time and labor to look after these matters. Institute and other formal meetings have come to assume a very great importance in our agricultural life, and when the meetings of the larger state bodies are added they become of dominant influence.

The scientific bodies at Newark, New York, Brooklyn, Trenton and Philadelphia have continued to receive my attention as well as the national bodies meeting at Washington and elsewhere throughout the State and the United States.

Miss A. E. Meske is still in charge of the routine and clerical work of the service, and, aside from circular work of the State Entomologist, something like 4,000 separate communications have been sent out. The bee inspection work has added very materially to her labors without adding anything to her pay.

Elm Leaf Beetle.

As stated in the report for 1910, the beetle brood for that season matured normally and entered the hibernating state in good condition. The prediction that was made concerning the probable numbers and extent of injury for 1911 was also fulfilled to the letter. Nothing occurred during the winter to lessen the number of beetles, and the adults came out in full force in early spring, although, owing to cool weather, a little more gradually than usual.

The first beetles were seen on the windows about the usual date in April, and the probabilities began to become more definite in early May, when large numbers of beetles were sent in by housekeepers who failed to recognize them and feared for their woolens and other supplies.

Shade tree commissions were early in the field, and those newly organized became active in good season; a few purchasing spraying outfits of their own, while most of them arranged to have the work done by one of the commercial companies.

The gradual development of the foliage of the trees and slow emergence from hibernation produced a long period of oviposition or egg-laying, and the earliest larvæ or slugs hatched before egg-laying became general. This made it difficult to time the spraying where one application only was to be depended on. It was my purpose to try this scheme on the College elms, and work was begun on May 16th and finished next day. The material was the Electro Arsenate of Lead, dry, 15 pounds in a 200 gallon tank.

A couple of slight but dashing showers, the rapid development of new foliage and the additions to the egg masses made me doubt the wisdom of relying on a single application; the more, as some of the work, done by a temporary assistant, was doubtful as to its thoroughness. A second spraying was made, therefore, beginning June 5th and taking part of three days. The material was identical, but only 10 pounds of the lead was used in the 200 gallons of water.

The result was all that could be desired. The trees never looked better in all their history, and they stood out in more or less sharp contrast to all the other trees in the city, sprayed or unsprayed.

The City Improvement Society arranged for the treatment of many of the elms by a commercial company, and one very imperfect application was made. So imperfect that some of the sprayed trees were in no way better than those not treated.

In my journeys through the State I kept a general outlook for conditions, and throughout, the cities and towns that made any effort at all to save their trees, were in better condition than the others.

As the season advanced the low temperature and drought told ever more badly on the city trees, and the work of the beetles and their larvæ became ever more apparent, until the time when the larvæ were full grown and about ready for pupation. Then ensued a period of intense heat and great humidity, and with this came the development of that disease trouble that swept out of existence millions of larvæ and pupæ and left for development into adults so small a percentage that their feeding was scarcely noticeable. When this condition of affairs was recognized in New Brunswick, I instructed all assistants to note conditions everywhere and to report concerning the manner in which adults of the summer brood were developing; and in a general way their observations agreed with my own.

To make matters yet more definite, however, I had a systematic examination made in several cities and towns, in some of which work had been done, in others of which nothing had been done, and part of the reports of conditions in late July and early August should prove interesting:

Rahway—		
Elm trees examined		234
Good to fair 18 per cent. or	42	
Dead and dying	52	
Probably beyond hope	100	
Savable	40	
		234
Elizabeth—		
Elm trees examined		625
Good to fair 35 per cent. or	222	
Dead and dying	95	
Probably beyond hope	219	
Savable	89	
		625
Bound Brook—		
Elm trees examined		71
Good to fair 24 per cent. or	17	
Probably beyond hope	43	
Savable	11	
		71
Somerville—		
Elm trees examined		307
Good to fair 16 per cent. or	50	
Probably beyond hope	210	
Savable	47	
		307
Plainfield—		
Elm trees examined		739
Good to fair 47 per cent. or	347	
Dead and dying	12	
Probably beyond hope	218	
Savable	162	
		739

Rahway has done practically nothing for her trees, and many elms have already been taken out.

Elizabeth looked after her trees for some years, but recently has neglected them.

Bound Brook has not done any systematic work that I know of.

Somerville is in the same case, and her plight is a bad one, because much of the beauty of some of the streets and open spaces is dependent upon the elms, some of which are very large and fine.

Plainfield has treated the greater part of its trees more or less ystematically, and the percentage of good trees is large. But the umber of very seriously injured trees is altogether too large for 'city' of its character, and another season of neglect with an in- urious infestation will turn a fairly good showing into a contrary ne.

A somewhat less detailed statement was prepared for Summit, 'hatham, Madison, Convent and Morristown, at all of which oints the trees have been systematically looked after by regular ade tree commissions or some effective body.

Summit—80 per cent. of the elms are in fine condition.
Chatham—45 per cent. of the elms are in good condition.
Madison—70 per cent. of the elms are in good condition.
Convent—Only a few elms, all in good condition.
Morristown—90 per cent. of the elms in fine condition.

The really important result of the inspection was not so much) bring out the condition of the trees at these various points, as) bring out the fact that the same conditions that operated at lew Brunswick to lessen the number of maturing beetles, operated lso at all these places whether trees were sprayed or not, and the mallest brood of adults for years past is now in hibernation.

This does not mean that everywhere there are only a few beetles n winter quarters—it means that the percentage of specimens that natured is very small, and that where trees were kept in good con- ition and larvæ were few in 1911, there will be very few beetles) start the season in 1912. It will offer also an excellent chance ı 1912 for those municipalities whose trees are not already be- ond hope, to get them into tolerably good condition to resist the ttack for that year.

Peach Borer.

Sanninoidea exitiosa Say.

Rather extensive observations were made and reported on in)10, and Bulletin No. 235 gives in compact form the conclusions at seem warranted from the observations made in this State. During the season of 1911 a little additional work was done, d the insects were kept under a general sort of observation.

In the nurseries Mr. Dickerson noted the presence of the insect rather more particularly and closely than usual, and broke down a considerable number of badly infested trees. The attention of tree growers was called also to the presence of the insect and a good many infested trees were undoubtedly thrown out by dealers. We did not, however, in any case make the presence of this insect in a nursery an excuse for refusing a certificate.

Mr. Dickerson also made two visits to the Mercerville orchard where some of our work was done in 1910, and there is no doubt that the work done there in the last year had a very good general effect.

June 16th, borers of small and moderate size were found in small numbers among others about full-grown and ready to spin up. Only two full grown pupæ were found.

July 6th, another search was made, chiefly for pupæ this time, and two empty pupal cases of this year's formation were discovered. In other words, adults had already begun to issue. The number of larvæ had been much reduced as compared with last year, and it was chiefly along the outer rows that specimens were found in any numbers. Only cocoons were brought in, and from these adults began to emerge, July 12th, and continued until the 24th of that month, when the supply was apparently exhausted.

Incidental examinations were made in orchards by Mr. Weiss and myself and more systematic work was done at Vineland and at High Bridge by Mr. Stafford. The first regular worming at Vineland was done June 12th, by Mr. Thrasher, one of the assistants in the horticultural department, and the results of the work were turned over to us. Quite a range of size was represented and there was one pupa.

June 16th, Mr. Stafford found them quite abundant in the experiment orchard—3 or 4 per tree and approaching full size. In the Voorhees orchard adjacent they were even more abundant, and some 200 well grown specimens were brought back to New Brunswick.

June 26th, at Vineland, in an orchard adjoining the experiment ground, found the larvæ abundant and well grown, and in some cases accompanied by a *Mycetoplylid* in considerable numbers.

Meanwhile I had been over the Gypsy Moth area in Massachusetts again and had noted the improvements made in tangle-

foot, and the extent to which it was depended upon to keep the trees free from caterpillars. I noted also, and this was confirmed by Mr. Rogers and others, that as now prepared, no penetration or injury accompanied its use, and that even the thin-barked trees could be safely banded, even when the material was put on an absolutely smooth surface.

I therefore arranged with Mr. Rogers for a pail of this thin tanglefoot for experimental work, and on June 30th, Mr. Stafford treated the trunks of 21 peach trees in row 25 of the experiment orchard. It was applied from the surface to about 18 inches above, and about 1/8 inch thick, forming, of course, a uniform sticky coat.

Borowax is a new protective material put on the market by the J. T. Lovett Co., of Little Silver, to prevent borers from injuring peach trees, and a quantity of that having been sent in for trial just in time for use here, was applied to 24 trees on row 26. It was put on quickly and easily with a brush, a little thicker than in rough painting, and it dried rapidly. On the east side of Dr. Voorhees' orchard, where the borer infestation had been worst, treated a row of about 40 trees—the fourth from the east edge.

July 10th, at Vineland, treated 20 trees with tanglefoot from the surface to a distance one foot above ground. These were trees right in the midde of a badly infested orchard which had not been wormed, and the plan was to capture the adults on the sticky surface as they emerged or before they had an opportunity to mate or oviposit.

July 14th, High Bridge, examined the tanglefoot and borowax put on June 30th. Borowax is perfectly dry, gives off practically no odor, has not in any way affected the epidermis beneath it and can be scraped off the surface as a waxy sticky powder. It forms over the surface of the bark a thin, hard, dry enamel, and that is all.

The tanglefoot was just about as when put on, except that on the surface greenish-yellow leaf-hoppers were very plentiful; moths of various kinds, a few; grasshopper nymphs, a few; adult Periodical cicada, one; Coccinellid beetles, a very few. Also a number of yellowed leaves. No *Sanninoidea* in any case.

Applied tanglefoot to 15 wholly untreated trees in the Voorhees orchard to determine the possibility of capturing moths

July 24th, looked over the tanglefoot trees and found stuck in the material, Coccinellids, Elaters, Bostrychids and Tenebrionids. A variety of Hemiptera and Jassids. Mosquitoes, Muscids and a variety of smaller flies. Various small moths. Chalcids and a variety of Hymenoptera.

While looking over these trees I saw a Capsid bug walk down, over the tanglefoot from about 6–8 inches above, to the surface and off to safety. I found a *S. exitiosa,* female, resting on the tanglefoot on one of the trees, head upward and about 3 inches from the ground surface. I was strongly under the impression that she was hopelessly stuck; but when I touched her with a pencil point to make sure of this, she took wing and flew without the slightest difficulty.

Tanglefoot seemed to have collected an infinitesimal film of dust over its surface such as would permit a delicate, light footed insect to walk over it.

August 1st, at High Bridge, there had been no change in the borowax trees, while the collections on the tanglefoot had increased without including any *Sanninoidea.*

August 10th, at Vineland, the tanglefoot, owing to hot weather was in prime condition as to adhesiveness and softness, and a very large number of insects were adherent to it; but no *Sanninoidea.* In view of the conditions that favored penetration I cut slivers from a number of coated trees and found no evidences of penetration. It appeared to have remained strictly on the outside in all cases.

The tanglefoot and borowax trees were, later on compared as to appearance with untreated rows adjacent and no differences were noted. Neither of the materials had the least injurious effect on the trees.

On the other hand, in some cases borer castings and exudations appeared in the treated area itself, so it is a question whether any good was done by the coating. But as some of the coatings were applied *after* the first moths had appeared, it is at least possible that the very young larva was already at work when the "preventive" was done.

Conditions at High Bridge were noted September 22d. The tanglefoot was as sticky as when first applied and formed the same complete and uniform coating. In none of the trees did I find any trace of borer workings nor were any adults stuck on the

treated area which was covered with a great variety of species in various orders.

The borowax on the larger trees of the experiment orchard is in much the same condition as when first put on. In a very few places, however, it had split with the growth of the tree. These trees are from 4 inches to 5 inches in diameter. In the Voorhees orchard, where the trees are 2–2½ inches in diameter, a large amount of splitting of the borowax coating occurred. In half a dozen cases, in such splits I found evidence of borers but not the borers themselves.

However, that was also the experience on untreated trees where similar evidence of borer attack was noticed without being able to locate the insect itself.

Neither tanglefoot nor borowax had in any way impaired the general health of the tree as compared with the untreated specimens, and both materials seem to remain strictly on the surface.

Judging from the record the tanglefoot is worthy of further, more systematic test, while the borowax does not offer much inducement in that direction.

A persistent effort has been made by a white lead company to secure the trial of one of its products, guaranteed as a pure lead, thinned down with a pure linseed oil, as a repellant or preventive, and some old experiences of my own indicate that if all conditions are favorable the material may work well. But if any benzine or turpentine is used in the paint it will mean either a dead or a seriously injured tree.

For the present I am not ready to add anything to the recommendations made for treatment, in Bulletin No. 235.

Cranberry Insects.

Weather conditions were extremely favorable to the development of cranberry insects and of injury to the crop, and as a result there was more complaint from growers than there has been for years past. The older, more experienced men in general, recognized the attacks under the new phases; many of those of less experience, accustomed to the usual good results of present routine, supposed there was some new pest at work, and a very instructive meeting and discussion on the subject was had at the Mount Holly meeting in August.

The winter of 1910–'11 was not very severe, contained no extremes of cold, nor on the other hand, any serious warm spells. It was simply a rather mild even sort of winter which was favorable for almost all sorts of insect life.

Vine-Worms.

Both the yellow-heads and black-heads were unusually abundant except where proper reflowing was practiced, and both for climatic reasons. Compared with 1910 the season was about two weeks late in starting, and spring temperatures on the whole were low. The results were that the eggs of the black-head on the water covered leaves of the vines remained fully dormant even where the water was shallow, until the water was actually drawn off, while the adults of the yellow-head were kept in winter quarters by cold nights until the normal period for uncovering bogs was at hand.

The result was an unusually heavy early brood of both yellow-heads and black-heads which, nevertheless, was not generally noticed by growers until it was nearly full grown, but which became conspicuous by a numerous and husky second brood.

Cranberries bloom and set chiefly during the early half of July, and that is exactly the time these vine-worms were present in greatest numbers, the black-head being the chief culprit in most cases. Large areas were cleaned up altogether even where spraying had been done and, where berries had already set, many were eaten out by the worms. And they have left their threat behind, for, in early August, on an Atlantic county bog I found eggs present in great quantity. On one runner I found every upright with at least one egg, and on some uprights there were from two to four leaflets with eggs present.

I have nothing to add to the remedial measures; nothing equals reflowing done at the proper time to kill off the first brood. Thorough spraying with Paris green or arsenate of lead will undoubtedly kill off a very large percentage of the larvæ; but their feeding habits are such that unless the applications are remarkably well-timed a great deal of injury will be done.

Cut-Worms.

There is nothing at present recognized on New Jersey bogs ch as a specific Cranberry Cut-worm. There are plenty of cut-rms that feed on cranberries and some, like the army-worm ten do serious damage on the bogs. Other, more typical species e reported each year, but scarcely twice alike from different alities, so that it is usually a local condition due to some species it becomes temporarily abundant.

One of the tricks of cut-worms is to climb to the tips of the nts, cut off the juicy terminal shoots or blossoms and thus se injury out of all proportion to the actual amount of vege-le matter eaten. This habit forms the basis of much of the nplaint of blossom worm for the current year and is, no doubt, ponsible for a very large percentage of the fruit loss not di-tly traceable to the work of the vine-worms.

Wherever cut-worms are known to occur on cranberry bogs, the ly sprayings of bordeaux mixture should have an addition of pound of Paris green for every 100 gallons of the fungicide.

Where reflowing is practiced, cut-worms will never prove seri-ly injurious.

Girdle-Worms.

More complaints of this pest have come in during the present mmer than ever before in my experience, and I have no satis-tory explanation for this fact. It is possible that a change in actice and a greater freedom of our bogs from grass has made a nge, for the insect is a grass-feeder primarily.

As to remedial measures, the best and most effective is undoubt-y a temporary flowing just after picking is completed. The væ are then still in open tubes and will not survive submergence re than four or five days. In case of serious infestation I uld advise a week, however, and this will not injure the plants hat season.

Burning off the infested area with a gasoline torch has been d with more or less success, and if that is done, the burning st be complete to the bare ground itself, and must be carried l beyond the dead area so as to be sure to get all the infestation. w plants can be set out at once on such a burnt over area and bare place covered rapidly.

It may be well to call attention, however, to the fact that not all eating along the vines at the surface of the ground is due to girdle-worm. Almost any of the ground beetles or grubs may do this from time to time, and even cut-worms score the bark occasionally. Crickets have been found gnawing the bark of the vines, and even white grubs are occasionally found in dry bogs.

The true girdle-worm is a green caterpillar that lives in a silken tube at or near the surface of the ground, and gets to be about an inch in length before it is full grown. The tube is covered with dirt like the surface soil, and is rarely recognized by the grower hunting for the caterpillar as the covering of the insect sought by him.

Tip Worm.

This has undoubtedly caused injury on some bogs; but usually where the growth was weak and the vines not thrifty. Uprights, runners and fruiting shoots are all attacked and the growth is stopped or stunted. It does not hurt the crop of a fruit bearing upright on the year it is attacked; but if the attack comes in August on uprights or fruit spurs, no buds form for fruits the year thereafter, if the vines are at all feeble or unthrifty. I have seen many bogs badly tipped yet with good crops and good fruit sets. But I have also seen—more of late years—where the set of fruit buds had been materially checked by this insect.

This species appears to be altogether beyond reach of insecticides. There is a more or less irregular breeding throughout the season, more abundant in early summer and less on reflowed bogs. In some localities it is almost unknown; in others it occurs only along the edges and higher portions of the bogs, and in most places it is least abundant on the deepest areas of the cranberry meadow.

Cranberry Practice.

Since I first began work on the bogs, in 1884, a vast change has taken place in practice. At that time little was definitely known of any of the insects, nothing at all of some of them, and our knowledge of diseases was a complete blank. First, as field agent for the United States Department of Agriculture, I spent two seasons on Cape Cod and in New Jersey. Then as entomol-

ist for the Experiment Station in this State I have gradually led gaps in our knowledge until, at the present time, most of our sts are pretty well recognized and the method of dealing with em is pretty well known to most growers.

When I first began work with insecticides our battery of poisons as limited, and our means of application exceedingly crude. eld and orchard spraying was in its infancy and the possibility covering a bog was not even seriously considered. But as mainery improved and poisons were shown to be effective, some owers who had an insufficient supply of water turned to spray ımps as an alternative to losing their crops altogether, and a fficient measure of success was obtained to keep alive and inease the practice.

As our knowledge of the cranberry diseases entered into a new ıge, and when it was demonstrated that some of these could be ntrolled by spraying, there was yet another factor, and now ere are no more elaborate outfits for the applications of fungiles and insecticides in New Jersey, than there are on our cranrry bogs.

And nowadays a sprayed cranberry bog looks quite different om the bog of olden days. Then grasshoppers—long and shorterned, and katydids hopped and flew up before you. Leaf hoprs swarmed, and so did hosts of beetles and other insects. There as good collecting for the entomologist at almost any time, and a urce of supply for a great variety of species whenever he wanted em.

In the early part of August, 1911, I visited, with Mr. Rider, e secretary of the Cranberry Growers' Association, an Atlantic unty sprayed bog. Not a katydid was seen; not a grasshopper cept along the dams, and scarcely a leaf hopper. There were no ass moths, no beetles, and for the entomologist there was a disessing lack of interest, except where the vine-worms had gotten their work.

May Beetles.

In number of specimens and species and in amount of injury, e season of 1911 was unique so far as "May-beetles" or "Junegs" are concerned. As soon as the first warm days of April me on the vanguard of the specimens made their appearance, though it was not until well along in May that they became

really abundant. No less than seven distinct species made their appearance in considerable numbers at New Brunswick, and others appeared in the vicinity in smaller numbers. Some of the species commonly represented this year are not usually abundant here, and all the usual species occurred in large numbers.

This was not a unique feature at New Brunswick, nor even in New Jersey, but seems to have been within the experience of a number of collectors in adjacent States. Up to the early days of June the insects continued in large numbers and then gradually declined until, during the last days of the month, only single specimens were obtainable.

The species in the order of their abundance at New Brunswick were: *Lachnosterna arcuata, L. dubia, L. hirticula, L. ilicis, L. fraterna, L. tristis,* and *L. fusca.* The species occurring after June 20th were not listed.

As to the injury caused that was not generally recognized. On a variety of shade trees they chewed the leaf stems and petioles and caused a dropping, the reason for which was not usually understood. On fruit trees blossoms were eaten and later the recently set fruit was scarred and disfigured to a greater or less extent. Peaches were not generally touched, but most of the smooth fruits except cherries suffered to a greater or less extent.

The actual injury caused by the adults is small, however, compared to the danger from the large crop of white grubs derived from this unusual abundance.

Rose Chafer.

This insect has been quite as abundant as usual throughout the southern part of the State, and has done just about the usual amount of injury. As is always the case, there were some localities where it was not quite as bad as it was during the few years last past, and corresponding localities where it was worse. In each instance the determining factor has been the opportunity that the larvæ have had for breeding, and the large vineyard areas in South Jersey that have been practically exempt from injury from this insect during the past summer have been so chiefly, because the methods of cultivation have practically done away with the opportunities for larval breeding.

The larvæ of this insect is a white grub. It lives under ground ıd lives on the roots of grasses and weeds. Wherever there are eedy orchards or vineyards, or neglected grass lands, there the ɛetles will breed. There also injury will be most severe during ıe season following.

As usual a great number of experiments were made with in-ɛcticides of all kinds to prevent injury, and either to repel the ısects or to kill them off promptly. For the first time there ems to have been some agreement in results during the present ason. It seems to be the uniform experience that the addition glucose to a mixture of arsenate of lead either increased the at-activeness of the poison to the beetle or its effect, and at all ents, that arsenate of lead at the rate of one pound in ten gallons water, adding a quart of glucose to the mixture, would kill where ıe arsenate of lead without the glucose had no such result. I did ıd a man who claimed that he had satisfactory results even ithout the glucose, using the arsenate of lead alone; but his was single case, while others who reported good results reported not ıly from New Jersey, but from a number of other States ex-nding almost to the middle west. It seems likely then that the ldition of glucose to an arsenate of lead mixture will give us ntrol over this miserable beetle that heretofore has defied our ost powerful poisons. Just what there is in the glucose that ould enhance the effectiveness of the arsenate of lead so ma-rially no one seems to know definitely up to the present time. e may for the present, however, accept it as a fact and use the ixture empirically until we manage to work out the explanation.

Other Leaf Chafers.

Quite a number of other leaf-chafers were sent in from time time during the season, or were taken on orchard or other fruits. mong these, one of the smaller and more unusual, was the irides-nt silky little species known as *Serica iricolor* which occurred ıring May on peach trees in the more southern parts of the State. It is one of those species that has a very brief period of flight, ıd it was possible to advise those that sent in specimens that the time information could get to them concerning methods of ntrol, the need for them would be over; and so it was in every stance, no appreciable injury having been caused in any case.

Larva of Fig Eaters.

Several times there were received from South Jersey after mid-summer the hairy white grubs of the fig eaters, or larvæ of *Allorhina nitida,* with the story that they were undermining lawns and grass plots generally and causing a great deal of injury. These insects are always more or less injurious in South Jersey after mid-summer, and the brilliant velvety green and bronze beetles are not infrequently seen flying about over the surface of the lawns. They occasionally get into such fruits as are ripe at that time; but as a rule attract attention only of the children who know them as "June bugs."

They are not harmful to cultivated crops, and on lawns it is frequently best to turn up the entire carpet of turf, destroy the grubs mechanically or with a strong kerosene emulsion and simply reseed or resod. Where the injury is less marked, kerosene emulsion washed through the turf will very frequently destroy the larvæ and save the grass.

The Spinach, or Beet-Leaf Maggot.*

Pegomyia vicina Lint.

This insect, in its larval stage, is known as the spinach, or beet-leaf maggot or miner, as in that stage it mines in the leaves of these plants. It was first reported by Dr. J. A. Litner, entomologist of New York State, in 1882, when he reared this and two other species of *Diptera* from beets and described it. Since then observers from the Atlantic to the Pacific have reported it as similarly injuring these plants.

In the New Jersey report for 1909, the species was noted as occurring at Richfield, Passaic county, infesting beet leaves to such an extent that it was impossible to bunch the beets.

*Prepared chiefly by Mr. E. L. Dickerson, from his own observations and from office notes and published data.

Field Observations.

arly in 1911 a report came from Little Silver, Monmouth ıty, that the insect had been troublesome in spinach in 1910, was again beginning to make its appearance. Accordingly, May 5th, Mr. H. B. Weiss visited the farm of Mr. H. M. les, whence the insects had been reported as injurious. The ach had made a good start, the leaves had become from half an to an inch and a half long, and on the under surface of a ber of them the white eggs of this species in clusters and singly : noted. A few had hatched and larvæ were seen in the leaves, injury being about one-eighth inch in diameter. Evidently osition had been in progress for several days.

ay 17th, I visited the place to note progress. In the spinach where Mr. Weiss had found the insects on May 5th, part of plants had been cut; but on the remaining ones more eggs : noted than occurred at the time of his visit. Many leaves several groups of eggs and some showed rather large mined ions. As some of these contained no larvæ it appeared as if w maggots had matured. In some cases maggots may have rated to fresh leaves, but I saw no evidence of this.

rowing along the rows of spinach were numerous young plants Lamb's-quarters or Pigweed, *Chenopodium album,* L., and cely a plant of this could be found which did not bear on its es a larger or smaller number of these same eggs. It ap- ed, here, that the flies had preferred this weed to the spinach : place for oviposition. While part of the eggs had hatched, ıy were still unhatched, and as flies were also to be found, it eared that egg-laying was still in progress. Next to the ach was a bed of beets, and while the leaves of these plants e sufficiently developed to serve for oviposition it is interesting ıote that only a small number of eggs could be found upon n. Some distance from this spot another and younger bed of ıach was situated, and this showed less infestation than the above noted.

Iay 26th, the place was again visited. The rest of the spinach he older bed had been cut, but there was much breeding in the es of the Lamb's-quarters, in and about the spinach bed, and in beets a much greater infestation was noted than on May 17th.

Breeding was also noted in the younger spinach bed and in other plants of Lamb's-quarters about the place. The flies did not appear to be as numerous as a week earlier, and while a number of unhatched eggs could be found, it appeared that most of the oviposition of this first brood had taken place.

Another visit was made to the Sickle's farm, August 1st, but no flies were noted about the place, and scarcely any eggs or larvæ could be found on or in the plants.

Not only was this species observed at Little Silver, but, as opportunity served, wherever Lamb's-quarters was found, it was examined to ascertain whether or not the fly was present, and in almost every instance some infested plants would be found.

May 18th, at Trenton and also at Newark, eggs were noted on Lamb's-quarters, and at Newark the maggots had begun to mine the leaves. May 22d, plants at several points in New Brunswick were found bearing eggs; in some cases the leaves showed a considerable number. Throughout June, plants bearing infested leaves and unhatched eggs were noted; but toward the end of that month the infestation seemed to diminish, and very little was seen of the insects in any stage.

July 6th, at Trenton, much Lamb's-quarters was noted about a peach orchard; a few of the plants had leaves infested with maggots and a few unhatched eggs were observed; but many plants which had been infested were free at this date. In late August a few eggs were found on Lamb's-quarters at Newark.

Breeding Notes.

Infested leaves of *Chenopodium* and spinach were collected at Little Silver, May 17th, and adults were bred in the laboratory from these as follows:

June	6	10	males,	7	females.	
"	7	11	"	8	"	
"	8	5	"	5	"	
"	9	..		1	"	
"	10	..		1	"	
"	13	1	"	..		(a parasite).

From infested leaves of spinach, beets and Lambs-quarters collected at Little Silver, May 26th, the following adults were bred in the laboratory:

June	13.....	39	males,	32	females.		
"	14.....	33	"	47	"		
"	15-16.....	18	"	32	"	5	(a parasite).
"	17.....	2	"	..			
"	18-21.....	10	"	4	"	22	"
"	26.....	..		..		2	"

In the above breeding the parasite was bred from infested leaves of all three species of plants.

Life History.

While the above breeding was carried on to determine the species at fault and whether more than one species was present, no effort was made to ascertain the length of the various stages. These, however, have been determined by Dr. L. O. Howard, who gives from 3 to 4 days for the egg stage, 7 to 8 days for the larval or maggot stage, and 20 days for the puparium or resting stage. These periods, nevertheless, vary to some extent, and Professor Bruner gives 10 days as the period required for one specimen to develop from larva to adult.

The life cycle of this species is briefly as follows: The eggs are laid on their sides, singly or in clusters, on the undersides of the leaves. When in clusters they are laid parallel, or nearly so, to each other, and as many as seven have been observed together, although groups of two, three or four are usual. The individual egg measures .03 in. in length, is somewhat oval in outline with rounded ends, has a reticulated surface and is white in color. When laid they must be somewhat viscid on the surface, to remain attached to the leaf even for some little period after the maggots have hatched. As many as 30 eggs have been noted on a single leaf.

As soon as the maggot emerges from the egg it makes its way into the tissue of the leaf and feeds between the upper and lower surfaces or epidermis. At first this mine is more or less gallery-like, but soon becomes an irregular blotch. Frequently several maggots will be found in a single chamber, but when enough food is not obtainable in one leaf the maggots will migrate to others.

This larva has the characteristic maggot appearance, superficially resembling the root maggots of onions and cruciferous crops, and when full grown measures 5/16 in. in length. It is whitish, somewhat hyaline in appearance, and in the specimens taken fresh from the leaves more or less of the internal structure is partially visible.

When mature, the maggot generally makes its way to the surface and penetrates the soil to pupate. The pupa, as is the case with all the species in this group, forms within the outer skin of the maggot, which hardens and forms the puparium. This is white at first, but gradually changes to a dark brown, is somewhat oval in outline and shorter than the full-grown maggot.

While pupation generally occurs below the surface, it may take place under the leaves or perhaps other similar objects on the surface or even in the leaves themselves, if they are on the surface. To ascertain the conditions of pupation the following record of some of the breeding jars was noted:

A few leaves of Lamb's-quarters infested with maggots of various sizes were collected at Little Silver, May 17th, and placed in a glass dish without any soil and left undisturbed. Between June 6th and 9th, 12 males and 11 females were bred out, and on June 13th, 1 parasite. July 5th, the dish was cleaned out and it was found that a very few flies had evidently dried up in the puparia without emerging, showing that the drying out of the material had affected the insects to a slight extent.

A small number of infested leaves of spinach obtained at the same time and locality were placed in a similar dish, and between June 7th and 9th, inclusive, 2 males and 3 females were reared.

To determine the depth of pupation in the soil, 4 breeding jars were examined. Each jar contained several inches of damp sand, and in two of them a number of infested leaves of spinach were placed while the other two received leaves of Lamb's-quarters. The following conditions were noted:

In or under the decaying and dry leaves on the surface	40	pupæ.
Between surface and ½ inch deep	43	"
" ½ inch and 1 " "	208	"
" 1 " " 1½ " "	156	"
" 1½ " " 2 " "	31	"
" 2 " " 2½ " "	11	"
" 2½ " " 3 " "	9	"
Over 3 inches deep	no	"

It is apparent that many of the partially developed maggots hich were not able to find enough substance to mature, made an ffort to pupate, but it was noted that the deepest pupæ if anything ere undersized. From the above results it is evident that the ormal depth of pupation is between the surface and 2 inches.

The emerging flies, save in color, superficially resemble those f the root-maggots. A well developed fly measures about a quar- r of an inch in length. The female is olivaceous ash-gray with ie legs, save the darker, reddish and these together with the wings, ie veins of which are red, give the insects a reddish cast. The ales differ from the females by being of a somewhat darker gray nd having the forelegs of a similar color, the mid and posterior gs being the same as in the female. As is usual in this group, ie eyes meet on the dorsal surface in the males and are separated i the females.

Seasonal History.

Based upon the length of time it takes the insects to mature, hich, as already noted, would be about a month from egg laying adult, and also upon the fact that the species has been observed i the field throughout the season, it has been suggested that there re six or seven broods annually. This, however, has not been etermined. Mr. Sirrine, several years ago, found in his investi- ations in New York, that the insects may hibernate in the pupal age, and I believe that this is the normal and possibly the only age in which they pass the winter. From these hibernating upæ Mr. Sirrine obtained adults as early as mid March, although ie majority of them did not appear until mid April. In New ersey the flies evidently do not begin to emerge until late April nd continue ovipositing well through May, and from eggs laid uring this period maggots were collected at Little Silver, May 7th and 26th, and flies bred out in the laboratory June 7th to 3th. Some flies of this brood undoubtedly emerged earlier than is and continued to do so for several days later. This irregu- arity of development would increase as the season progresses, and the insects continued to breed as rapidly as early in the year ey would, toward the end of the summer, be found in the field i all stages of development, at the same time.

It is to be observed from the record of observation, as here oted, that the insects appeared to decrease in numbers toward mid-

summer, and that when the Sickles farm was visited on August 1st, very little was seen of them either in spinach, beets, or Lamb's-quarters, although they had been breeding abundantly in these plants there early in the season. This, however, seems to be contrary to conditions which were noted several years ago by Mr. Sirrine in New York State, as in his report for that year he states: "Throughout the past summer it has been impossible to find a plant of Lamb's-quarters that did not have some of these maggots in the leaves. During the fall they have attacked the spinach so severely that it was impossible for the farmers to sell their spinach after carting it to market. The injury to beets has not been so marked."

The bad infestation of and consequent injury to the infested plants in the fall of the year has been observed by other investigators, but in New Jersey all the injury to plants noted occurred in the spring or early summer, and the growers report that they have not been troubled by the insects later in the season.

There is another point of interest in this connection. One of the breeding jars in which a number of infested leaves were placed in May, and from which flies had emerged in June, was examined in August, and it was found that the number of pupæ was considerably larger than that of the flies that had emerged. It is true that a number of the maggots, in the collected leaves, which were so small that they had been unable to feed sufficiently to develop properly but had, nevertheless, been able to pupate would fail to mature, while other pupæ had apparently died owing to the immature conditions of the soil in the breeding jar. Nevertheless, a few of the unhatched pupæ appeared, at the time the jar was examined, to be in good condition. It may be that all of the flies developing from this spring brood of maggots do not emerge at the same period; but that while some emerge within the normal time of a month, others lay over for a longer period.

Enemies.

Under the record of breeding it will be noted that two species of parasites were bred, one specimen of *Apanteles*, a new species, and several specimens of *Opius anthomyiæ* Ashm. It is further interesting to note that these were bred from the maggots in all

three plants, beets, spinach and *Chenopodium,* and that in nearly all cases they emerged after all the flies had emerged in the same jar.

In his investigations in New York State, Mr. Sirrine observed that dead larvæ were often found in the leaves, and that a common predaceous bug, *Coriscus ferus* L., was apparently responsible for their destruction. The latter was not observed in our investigations, but as it is a common species, it is probable that it, as well as the species of bred parasites, and other yet unrecorded parasitic and predaceous enemies assist in holding this insect in check wherever it occurs.

Food Plants.

It has been stated that the insect was found breeding in beets, spinach and Lamb's-quarters, *Chenopodium album* L., and so far as known these are the only species in which the insect has been observed breeding. They all belong to the family *Chenopodiaceæ,* and it may be that other members of this family will also be found to serve as food plants of this species. At any rate in the various localities where Lamb's-quarters has been observed this insect has been found feeding in it, and from the records of other observers this is also true in other parts of the country. This common and widely distributed weed is apparently the natural food plant of this insect, and hence it is evident that the insect is likewise generally distributed. It is interesting to note that all three of these plants are of either Oriental or European origin, like some other members of the same family.

Injury.

The injury caused by these insects is principally in spinach. This is always used for "greens," and even a moderate infestation would tend to reduce the value of the crop, while a bad infestation would make it unsalable. This would apply equally to beets when the leaves are used in the same way, but in cases where they are grown for the beets the worst injury is in the retarding of development. Sometimes, however, the infestation has been so great, as already noted, that the beets could not be bunched. In New Jersey, as already stated, the injury has only been noted early in the season.

Remedies.

Very little has been attempted in the way of remedial measures. Mr. Sirrine tried spraying the leaves with kerosene emulsion with the result that the leaves were injured while the maggots were apparently unharmed.

Cultivation of the soil for the destruction of the pupæ has been suggested. While some of the individuals would undoubtedly succumb to this treatment it is questionable how large a percentage this would affect. Whether the disturbance of the puparia in itself is disastrous to them is questionable; but appears not to be the case from the following experiments:

Infested leaves of spinach and Lamb's-quarters, collected May 17th, were placed in a breeding jar on moist sand and the jar left undisturbed until June 3d, when the contents were examined, the puparia picked out of the sand and placed in sand in another jar. Between June 6th and 10th, twelve male and ten female flies were bred.

Again on May 26th, infested leaves of spinach were placed on moist sand in a breeding jar and the jar left undisturbed until June 7th, when the contents were examined. The sand, small lots at a time, was placed in water where the puparia floated, were picked out, placed in moist sand and then the sand containing them thoroughly mixed up with more sand and all placed in a breeding jar. Between June 13th and 16th, inclusive, 23 males and 29 females emerged, and June 21st, 2 parasites. And it is to be noted that the proportion of flies emerging to the puparia contained in the breeding jar was as great as where the puparia were left undisturbed.

While the puparia, according to the conditions noted in the breeding jars are normally situated not more than two inches below the surface it is doubtful whether cultivation would be very effective against the pest because of burying them deeply in the soil. Mr. Sirrine has observed that the species is able to emerge when puparia are buried eight inches deep, and I have found the same fact to hold true in the case of the cabbage maggot (*Phorbia brassicæ* Bouche), although puparia of the latter are normally situated at a greater depth than those of this species.

The greatest effect cultivation would have would undoubtedly be in bringing the puparia to the surface where they would be exposed to any enemies and to drying out. To what extent they would be affected by the latter, however, is also questionable. As already noted from a few infested leaves collected in May, placed in two glass dishes without sand, and left undisturbed, flies emerged in June. As the leaves were only few in numbers in each dish they soon formed dry masses, and while this drying was not sufficient to retard some of the flies a few of the pupæ seemed to have been destroyed by it. Under field conditions where the puparia were turned up to the surface and the ground became hard and dry with the puparia exposed to the hot sun, it seems probable that most of them, under those conditions, would be destroyed.

The most important remedial measure is undoubtedly the destruction of the food plants. As already stated Lamb's-quarters is a common and widely distributed weed and occurs plentiful in many places. This should not be permitted to grow on a place troubled by this pest, and every plant possible should be destroyed. If this is done frequently so that the maggots do not have an opportunity to breed, the plants, if few in numbers, may be allowed to lay where they are cut off. If, however, the maggots have had a chance to breed for a few days, it will be necessary to destroy the plants, since in many cases the partially grown larvæ would find enough nourishment in the drying foliage to complete their development. In no case should the cut plants be gathered up in piles unless they are to be at once destroyed. What is said in regard to the Lamb's-quarters applies equally well to infested leaves of spinach and beets.

So far as conditions have been noted in New Jersey, it is suggested that where the insect is troublesome in the spinach an effort should be made to force the early crop so as to get it off before it has had an opportunity to become infested to any extent. In regard to beets it is questionable whether they could not be protected when they are grown in frames, by a cheap cheese cloth covering.

The Periodical Cicada.

Tibicen septen decim Linn.

In 1894 when I recorded the distribution of this brood, then known as No. XII., in New Jersey, I scarcely expected that I would, in 1911, have the opportunity of verifying and extending my observations concerning it. It is a remarkable example of the uniformity of nature's processes that, absolutely on time, seventeen years after the records made, these Cicadas appeared in practically every place where they had been previously observed and in practically similar numbers.

Since previously writing of these insects there has been a renumeration of the broods by Mr. C. L. Marlatt, and this old Brood XII. is now Brood II., and will be so referred to whenever necessary.

August 1st, 1910, to advise orchardists, a circular of warning was issued and distributed to the entire bulletin list as well as to all the news and other papers issued in the State. This was generally reprinted and called attention to the distribution of the insect, to the probable dangers to be apprehended and suggested care in pruning and setting out orchards in localities where the insects were known to be due in large numbers.

This resulted in considerable correspondence and many questions were asked concerning danger in specific localities. In general, I advised planting in long cleared areas, in those sections where previous reports were negative, and where the distribution of the English sparrow was such that a moderate infestation would probably be cared for. I found fruit growers generally inclined to take a chance and to risk setting out trees rather than lose a year, and in most localities I did not discourage that, recommending only that the trees be either very severely or not at all cut back. But I did in all cases discourage new settings on recently cleared land in infested areas.

Pupæ were received from correspondents here and there throughout early May; but there was no general approach to the surface until about the middle of the month. The first regular emergence was observed May 19th at Husted, Cumberland county, by Mr. Harry B. Weiss, and thereafter almost every day brought

a record—May 25th being perhaps the date of first general emergence throughout the State. By June 10th the brood was out, copulation was general and egg-laying had begun.

June 8th, Mr. Stafford collected both sexes infested by the fungus and with abdomen dropping off, and thereafter infested specimens came in greater or less numbers from all localities. This peculiar disease, due to *Masospora cicadina* Peck, undoubtedly lessened the numbers of these insects without, however, materially reducing the numbers provided for the next brood.

Throughout June the song of the males could be heard; but in decreasing volume toward the end of the month, while the evidences of egg-laying became ever more obvious, and little colonies, theretofore unnoticed became noticeable. Not until after July 19th did the last examples disappear from large colonies, and the first developing larvæ from eggs were not found until the last days of August.

Observations Made.

The entire staff was under orders to note all Cicada appearances and other facts concerning them, throughout the season.

Mr. E. W. Stafford was especially assigned to the vicinity of New Brunswick and to the regions round about Vineland, in Cumberland county, and High Bridge, in Hunterdon county, because the line of special investigation assigned to him kept him for a large portion of the summer in these localities.

Mr. Harry B. Weiss was especially assigned to the southern part of the State as a whole, because of some experimental work to be done at Husted, in Cumberland county, and because in the course of his nursery inspection work during August he covered almost every southern county to a greater or less extent.

Mr. Edgar L. Dickerson was, in the same way, especially assigned to the more northern counties, because the nurseries in that area were his especial care during August, and because during early July he made a carriage trip of two or three days through portions of Morris county.

Mr. Charles S. Sharp, as bee inspector, covered a large area in the State rather fully, and he was instructed to turn in memoranda of all positive observations.

Mr. Herman H. Brehme covered all the shore points from

Newark to Beach Haven, and turned in all positive observations made during the season.

Mr. Henry H. Brehme investigated in detail the occurrences in the vicinities of the cities and towns of Essex and Union counties and noted, interestingly, in several instances the results of sparrow attack on the species.

Mr. H. F. Smith was sent over the lines of the Susquehanna and Western and D., L. & W. Railroads to observe infested points after the effects of egg-laying had become obvious, and Mr. R. S. Patterson was in the same way sent over the Belvidere Division of the Pennsylvania Railroad for the same purpose.

For myself I have been in almost all parts of the State except the extreme north, either by train or in a motor, and my own observations are simply as supplements to those of my assistants. It is fair to say that except where especially noted lack of definite records can be considered good evidence that the insects did not exist.

Injury Done.

There have been the usual reports of excessive abundance, of trains and motor cars having been stopped and of drivers or passengers in carriages having been attacked, but on the whole there has been less of this than in any previous infestation.

Some, even serious, injury has been done, but it has been very local. The worst trouble has been in a section of Gloucester county, where on recently cleared land, immense orchards of apples and peach have been set out. One area of 30,000 trees is practically ruined by the egg punctures. A small number of trees two years out were also much injured and some of them were ruined. There was some injury of that kind almost everywhere; but on the whole not so much as might have been expected. Another kind of injury occurred on bearing trees, where the terminal twigs were stung and weakened so that they broke under the weight of the growing fruit. On one six-year-old peach orchard almost the entire crop was lost in that way, and that, of course, meant a direct and severe money loss, besides the injury to the trees.

Besides the orchards, raspberry plantations seem to have been the chief sufferers, but on these the injury is very temporary and will be completely worked out by the end of the season.

On the whole, while a few individuals have been very hard hit, the actual injury caused by the Cicada has not been very great, taking the State as a whole. It should be added in this connection that no injury at all was done by feeding; only by the egg-laying punctures.

The Dwarf Race.

Cassinii Fischer.

With almost every appearance of this species a certain percentage of specimens occur that are smaller than the normal form and show other peculiarities that indicate a different species, while agreeing absolutely in habits and methods of work. They seem to herd by themselves to some extent, are usually noticed early in the season and are subject to exactly the same sort of enemies and diseases.

They were noticed this year in Bergen, Passaic and Middlesex counties, and all the observers from whom I have records agree that the song of this type was recognizably distinct from that of the normal form, and that they seemed to run in small colonies by themselves. There is a very general inclination on the part of these field observers to recognize a distinct species, and there is sufficient structural difference in the sexual characters to make this at least a probability.

Chimneys.

These are always local, and have been described at length and figured in my reports on earlier broods. In 1911 they were reported from Bergen county, along the eastern slope of the Palisades, from the southern bank of the Raritan river and from a small area in Gloucester county, where I saw them myself and where they were remarkably perfect.

Natural Enemies.

The fungus disease, *Masospora cicadina* Peck, already referred to, was universally present, and is, no doubt, the most wide-spread general check to the increase of the insect. It comes early enough to prevent reproduction in a large percentage of cases; but seems

to favor the females by passing them by for males, and by reaching its climax of efficiency *after* oviposition is well under way. The astounding thing is that the abdominal viscera of the Cicada are of so little importance to it that specimens that have lost that part altogether nevertheless fly about and live on, apparently as happy as ever.

Next to this fungus the sparrows did their share in reducing numbers, and since they began with the first specimens that appeared and kept up the fight continuously, it amounted to practical extermination in some city and town localities.

There is also an enormous mortality in the eggs laid in the twigs. Hundreds of twigs were cut open during the early part of the season, and a very large percentage of collapsed eggs was always found. From observations made this year and previously I believe that much less than half the eggs laid in the branches ever develop into larvæ.

The next large brood of this insect is due in New Jersey in 1919, while the next occurrence of the present brood, No. II., is due in 1928.

Occurrences in Detail.

To bring out more in detail just where the insects appeared during 1911, and how this compared with the records for 1894, the following details are given by counties for convenience and future reference:

Bergen County.—In 1894 the record was: "They occurred throughout the whole of Bergen county, and were especially reported from Tenafly, Carlstadt, River Vale and Mahwah."

During 1911 this distribution was confirmed and actual observations showed the insects present from Fort Lee northward to the New York line along the top of the Palisades and on both slopes. There were none in the Hackensack valley and in the low marsh areas; but on the highlands west of the valley they reappeared, extending northward from Rutherford and more or less local. At Rutherford there were a few only as early as May 25th, and on some farms to the north none at all were observed. They were local at and near Ramsey, while at and near Westwood there were millions of them in some places.

Quite a bit of injury was caused on some localities on apple and peach, the latter suffering much more severely.

A characteristic feature in this county was the occurrence of the small variety in great numbers, on the summit and on the talus from Englewood to one mile beyond Alpine, in patches of small extent, where they were observed by Mr. Sleight and others of the New York entomologists.

Chimneys were observed by the thousands at Alpine dock and one mile north along the clay slope between the river and the rocky talus, by Mr. Sleight, and at other points in the same region by other observers.

Passaic County.—In 1894 they were reported from Paterson and from the Greenwood Lake districts, while negative reports came from the southwestern portion.

During 1911 this range was much extended and probably includes all the highland in the county, though, of course, not to an equal extent. At Paterson they appeared May 25th, 26th, and became excessively abundant in the Totowa section. From this point they extended abundantly along the line of the Greenwood Lake Railroad to Little Falls, and covered the lake district. Along the line of the Susquehanna and Western Railroad they extended to the Morris county line. At Pequannock they did serious injury on all fruit trees. They occurred throughout the Lake Macopin region and for about six miles northward very abundantly. At Hackensack the insects were reported June 1st, and that gives a pretty general distribution throughout the county.

Though it is known that the insects were not uniformly distributed, I have no definite reports of non-occurrence over any considerable area.

Sussex County.—In 1894 they were reported from Huntsburg and Papakating only; negative reports coming from a number of other points. In 1911 very little was added to this. They were definitely noted at Sparta and at Newton where, indeed, they were accused of stopping railroad trains on June 23d. "The locality known as the narrows near Newton is alive with them, and their musical hum can be heard for a mile." It is more than probable that they appeared in other localities in this county, but there certainly was no uniform or general distribution that could be noted along the ordinary lines of travel or that attracted the attention of the department correspondents.

Warren County.—In 1894 the insects were reported at Rocksburg only. In 1911 they were noted at Washington, at Hamburg,

June 1st and 2d, and at Port Murray along the line of the D., L. & W. Railroad. Negatively, there was no appearance of the insects, except where above noted, along the lines of either the Belvidere Division of the Pennsylvania Railroad, the Susquehanna and Western or the D., L. & W. Railroad. There were other isolated localities probably, but certainly no general distribution or great abundance of specimens.

Morris County.—The report for this county in 1894 was that it was covered in all its parts, but very irregularly, the reports of greatest abundance coming from Boonton and the eastern districts. The general distribution was confirmed in 1911, but more definitely so far as actual distribution was concerned.

They occurred all along the line of the D., L. & W. Railroad to Lake Hopatcong and at Morristown and Morris Plains were said to have been so abundant that their decaying bodies created a stench. Along the line of the Susquehanna and Western they were equally in evidence from Newfoundland and Charlottesburg to Sparta in the wooded areas on both sides of the road, and they were plentiful on the Newark watershed. They were especially reported from Chatham, Denville and Dover, and from that point to Wharton. So also from Mendham, Millington, Mt. Tabor and points north and south of Dover.

Mr. Dickerson reports, on a drive from Chester, that on the hill between Chester and Flanders (Pleasant Hill) the insects occurred in patches, but none at Flanders itself. They were present on Mt. Olive, but there were none at Budd's Lake.

In this county considerable injury was reported in peach orchards, but as usual the injury was irregularly distributed. Perhaps nowhere else were the insects more in evidence along the main lines of travel than here, and reports covering these lines are numerous.

Essex County.—In 1894 this county was reported as infested everywhere in almost equal abundance, and with slight modifications that report may stand for the present year. Whatever modifications have taken place are due to the increased numbers of sparrows and the cutting of woodlands. Nevertheless, in almost every town and village the insects were found and reported, and throughout the wooded slopes of both ridges of the Watchung mountains, their song was heard and their injury was noted.

The earliest date was at Essex Fells on May 20th, and thereafter every day produced a new record until their presence was universally recognized and attracted no further attention.

Hudson County.—Reported in 1894 as universally covered except for the flats and marshy portions, along the Palisades and down to Bayonne. Very little Cicada ground now remains in this county. Every available area along the Palisades has been built up and sparrows are on the alert for every unfortunte Cicada. Down toward Bayonne nothing is left for them, and practically the only bit of remaining highland suitable for their propagation is in the vicinity of Snake Hill. That is about all that remains of the once extensive colony in this county, and at the rate that changes are now proceeding there will be very little chance for those due in 1928.

Somerset County.—In 1894 my reports from this county were scant and indicated that the insects occurred in a few localities only. The reports for 1911 are more complete, but indicate only a local and somewhat scattering infestation, chiefly in the northern portion. They were abundant in Washington Valley back of Pluckamin and extended all the way along the road to Basking Ridge. They occurred in spots all the way from Bound Brook to Bernardsville, and sometimes in considerable numbers, but there was no general distribution. Scattering specimens were noted at Somerville and Raritan and there was a considerable colony in the oak woods west of Raritan.

Hunterdon County.—In 1894 all but one report from this county were negative; the one exception being in the northwestern corner. In 1911 I was a little more successful. Mr. Stafford found the insects in some numbers at and near High Bridge while engaged in work in the peach orchards. They extended throughout the hills southeast toward Lebanon, but were not noticeable along the lines of the railroads through here. Mr. Dickerson found egg-punctures in the peach nurseries at Fairmount, near the Morris county line, but nothing was found at White House, New Germantown, nor in the other peach nursery districts of this county. Along the line of the Belvidere Division of the Pennsylvania Railroad, traces of the insects were seen at Lambertville, they were rather more abundant at Stockton and Ravenlock and petered out before the northern boundary of the county was reached. There were none at Ringoes.

Union County.—In 1894 "Union county was generally covered, reports showing their presence everywhere." This is still true in a general way, but to a much reduced extent. I saw the first examples coming up in the streets of Roselle, May 25th, a little before dusk, and there were some in all of the towns along the line of the Central Railroad. At Fanwood, indeed, they were abundant. So along the line of the D., L. & W. through this county and notably at Summit. In the outskirts of Elizabeth and at Springfield egg-punctures were found in the nurseries at inspection time, although not in great numbers. At Rahway detached wings were mostly in evidence, the Cicadas themselves having been destroyed by the sparrows. It is safe to predict a much reduced brood for 1928.

Middlesex County.—In 1894 they were recorded as "irregularly distributed, more plentiful north of the Raritan river and petering out toward the south and west. Along the Raritan river I found them abundant nearly to Perth Amboy and petering out at Bound Brook. They were in patches to Jamesburg and on the line of the Amboy Division of the Pennsylvania Railroad, and extended into Monmouth county." Nineteen hundred and eleven has extended this distribution somewhat. At New Brunswick the insects were in the outskirts to the south, plentiful at the College Farm, where they were collected and observed by Mr. Stafford. Along the line of the Pennsylvania to the northeast colonies were observed on both sides of the road in patches of woodland from Stelton to the Union county line. From New Brunswick southwest along the same line not a colony was observed to the Mercer county line. Very little was seen along the south bank of the Raritan toward Bound Brook, but along the north bank colonies were noticeable all the way up to the county line. From Rahway to Perth Amboy and along the north bank of the Raritan from Metuchen to Perth Amboy colonies were in almost every patch of woodland and along the south shore of the Raritan they were abundant in the scrub-land to South Amboy and beyond it to the banks of the Cheesequake. From New Brunswick to Old Bridge an occasional colony was seen in the woodland, and these became less numerous to Dayton and Jamesburg in one direction and Matawan in the other. Between Jamesburg and Dayton a small colony was found, and then to the Mercer county line nothing more occurred. It was therefore in the eastern half of the

ounty that the insects were most numerous, while toward the Monmouth and Mercer county lines they petered out.

May 26th marked the date of first emergence on the College Farm, and on the 27th numerous wings indicated that the sparows were already at work.

June 17th, Messrs. Dickerson and Grossbeck collected along the iver east of New Brunswick, finding the small form in considerble number as well as some areas where chimneys had been plenful although now pretty well broken down. At this date also he fungus disease was getting in its work on both sexes, and many pecimens had already lost part or all of the abdomen.

In the Milltown area Mr. Stafford collected egg-punctures and etermined that the young began to emerge and drop to the ground uring the last days of August.

Mercer County.—In 1894 I noticed them only on the road to Lightstown and had no positive reports of their presence elsehere. This same small colony was again noticed between Lightstown and Yardville; scattering signs were noted in the icinity of Princeton and on the New Brunswick road, and a very ew were reported along the line of the Belvidere Division, near ne county line. Otherwise the country was almost free from hem along all the railroad lines and along the main roads over hich I rode in an auto on four separate occasions.

Monmouth County.—In 1894 my reports from this county were ostly negative, but I found punctured twigs in a number of calities in the eastern portion. There is not much more to add or 1911. There was a large colony near Matawan, and a still reater one at Cliffwood, where raspberry canes were severely inured on a small area. But there was nothing in the woods back f the shore from Red Bank to Point Pleasant, and nothing in the reehold region nor in those sections of the Pines seen by me. t is possible that near the Ocean county border there may have een some small colonies toward Lakewood, but there was no definite report.

Ocean County.—In 1894 they were recorded in small patches ere and there, Toms River being the worst infested portion, and nother center existing at Cassville. As it happens neither of ese localities was again reported in 1911, but there was a conderable area about Lakewood that proved to be infested. Mr. ickerson found them local for a distance of five or six miles on

the road to Holmansville which, by the bye, is not so far from Cassville. Mr. Sharp found them south of the town "thick as flies on a cow," and oak, chestnut and fruit trees badly hurt. Mr. Davis found them in the gravel hills at South Lakewood, and west of Lakewood; at Ridgeway and not far north of the Ridgeway river. None are in the true pine barrens. I saw none at Ocean Gate, along the south shore of Toms river, nor along the line of the railroad from Barnegat pier to Camden, so far as the line extends through Ocean county.

Burlington County.—In 1894 I reported it spotted by colonies here and there, one of them near Pemberton, but as a whole the reports were negative. I expressed the belief that toward the shore there would be more colonies. The season of 1911 added nothing to our knowledge in this direction; on the contrary, not a single positive record was received from this county despite the fact that both Mr. Weiss and myself traveled through it rather extensively by railroad and auto. There was certainly nothing north of the Pine belt and nothing along the line of the Delaware river. Several cranberry bog owners whose marshes lie in the pine belt of the county, assure me they saw nothing of the insects, and while there may be some infested gravelly areas they must be few and small.

Camden County.—In 1894 the insects were reported from Pensauken; I observed them along the lines of the Atlantic City Railroads to the Atlantic county line, but local and in no great numbers. At Clementon they were abundant enough to cause injury in chestnut groves. Except for Pensauken, where nothing was found, these localities were verified in 1911. There were millions of them at Almonesson, and at Blue Anchor they were seriously injurious to raspberry canes. They extended from Florence to Williamstown Junction and along that branch into Gloucester county. They appeared along the road about four miles east of Haddonfield, and the distribution was spotty on gravelly areas throughout the county.

Gloucester County.—In 1894 they were reported from Franklinville, and I saw them at several points north of that place along the line of the Cape May Railroad. In 1911 they were noted near Woodbury, at Malaga, and along the line from Williamstown to Glassboro. There were several large colonies within a few miles of Glassboro, and very serious injury was caused in some locali-

ies—as many as 30,000 young fruit trees were killed or crippled n one district alone. Some bearing orchards were badly hurt, nd this applies to apple as well as peach. Many square miles vere covered by the insects, yet there were many gaps also and nany acres of orchards were absolutely unharmed.

In some localities some of the best chimneys of the season were 'ound and good samples were obtained.

Atlantic County.—In 1894 was reported as infested throughout, but irregularly. I found them all the way from Hammonton o the coast along the Atlantic City Railroad, and at other points long the Cape May county line. This is pretty nearly the ruth as shown in 1911, but Mr. Rider pointed out to me that the nfestation was practically confined to gravelly knolls or areas, nd that none occurred in the sandy barrens. This was beautifully illustrated during the middle of August when I made a ittle trip into the cranberry country with Mr. Rider and through a portion of the pine areas southwest of Hammonton. There was also an area of infestation along the course of the "fast line" from Pleasantville to Somers Point, though the points were scattered and usually small except at Linwood.

Cumberland County.—In 1894 this county was compared to Atlantic as to manner of infestation, specific points mentioned were Bridgeton to Millville and the line of the West Jersey from Vineland to Cape May county. This distribution was verified in 1911. Mr. Weiss found them as early as May 19th in the vicinity of Husted and about Bridgeton, and they occurred along the line of the Central Railroad between that city and Rosenhayn in all the wooded sections. Mr. Stafford watched the species at and in the vicinity of Vineland, and found several large and scattered colonies there. He also observed them along the electric line between Malaga and Newfield and along the main road to Millville.

This somewhat amplifies the previous record and points to the correctness of the general conclusion that all suitable localities were more or less infested.

Salem County.—In 1894 this county sent negative reports except from the narrow strip lying east of Friesburg, which is close to the Cumberland county line. During the season of 1911 Mr. Weiss found a few infestations between Elmer and Palatine, but

not an office correspondent from this county referred to them. The county just escapes having no part of this brood within its borders.

Cape May County.—In 1894, all save the low lands supported great numbers, and at Woodbine the insects did perhaps more real injury than in any other part of the State. Practically this same record stands for 1911. Mrs. E. S. Starr of Ocean View observed the insects for several miles in her vicinity. Mr. Weiss made the trip to the shore over the West Jersey to note conditions, and Mr. H. W. Wenzel of Philadelphia sent me a record of his observations. Definite records extend from Tuckahoe into the peninsula gradually petering out to the shore. Woodbine and Dennisville in plenty. Sea Isle Junction and Wildwood Junction a little. Between Seaville and Swain in patches. South Seaville, in the woods everywhere. Mount Pleasant in enormous numbers. All the wooded parts of the peninsula in gravelly lands.

The Plum Curculio.

Conotrachelus nenuphar Hbst.

During the summer of 1910 the Plum Curculio attracted more attention than any other insect of horticultural interest in New Jersey; principally because of Mr. Blake's insistence concerning its importance in the peach orchard. I had, of course, a very extensive acquaintance with the species from almost all points of view and was not inclined to underestimate its importance; but I must confess that I could not work up any very great excitement over a money loss in peaches due to curculio injury. Nevertheless I followed out Mr. Blake's line of argument with experimental work, and am free to admit that given his premises and theories of marketing, the heretofore negligible injuries of the curculios assume an importance in some cases that from the money standpoint completely overbalance everything previously comprehended. But even here not altogether, nor in all cases.

Mr. Blake sells his fruit upon its appearance in the market and expects fancy prices for fancy fruit. Naturally every defect counts against him, and every curculio egg or feeding puncture that mars the cheek of an otherwise perfect fruit, detracts from the price. When some of the glorious fruits produced by him

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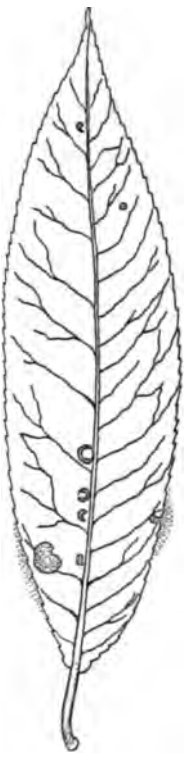

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Figure 5.

oung shoot on peach tree on which adult Curculios are feeding at *a* and *b*. At both points holes were bored down to the depth of the Curculio antenna.
each leaf, showing surface feeding of Plum Curculio.
each blossom on which adult Curculio had been feeding at *a* and *b*. At both points holes were bored down to the depth of the Curculio antennæ.
each leaf, showing surface feeding of Plum Curculio.
pple leaf, showing surface feeding of Plum Curculio.
lum leaf, *showing surface feeding of* Plum Curculio.

have been seen, a curculio defect easily becomes a personal offense and naturally enough the question arises whether something cannot be done to prevent this trouble.

The matter becomes simplified because in years of normally excessive crops, very few fruits are injured at picking time, and they are mostly of the earlier or earliest varieties. So far as curculio injury is concerned a crop will run sometimes all day with practically no appreciable injury of that character. I sat on one occasion for two hours watching the facing of firsts and extra choice as they came up without noting a single reject for curculio injury, although the variety was Carman, which is among the susceptible ones.

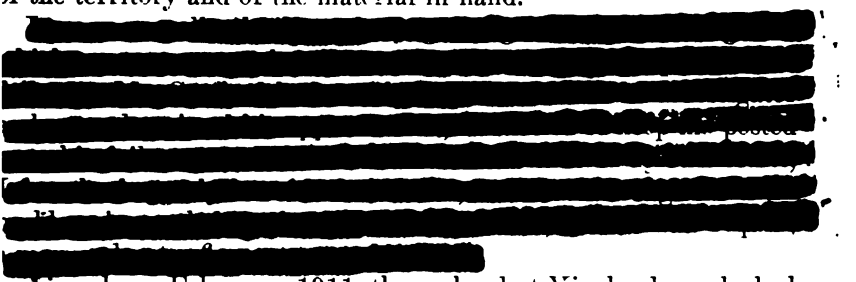
Mr. E. L. Dickerson, Mr. J. A. Grossbeck and myself were all interested in the work, as were Mr. Blake and his assistants, and we secured from the Experiment Orchards at Vineland perhaps the largest lot of specimens of dropped peaches for critical examination ever examined at one time. Most of the work and all the tabulation finally fell to Mr. Grossbeck's part, and that appears in the delayed pages of the report for 1910.

There were a variety of other questions that this gave us an opportunity to settle, or at least to make a stab at. How much is rot dependent on this insect and how generally is curculio and rot associated.

Mr. Blake and his collaborateurs were good tillers of the soil, good sprayers, and the numbers of our counts were well over 5,000 of which nearly one-half dropped from the trees to the benefit of the trees themselves. Over 500 dropped simply from defective pollination or inherent weakness, and of those on the ground nearly 800 had started to rot without any trace of curculio feeding or other mechanical injury to depart from. There are a number of other very interesting facts shown in those tables, and when they are carefully compared with some of the tables shown in this report the facts will show up new life and new interest.

At all events the outcome of the investigation was such that I felt sure that there was a season's work in the orchard for a man who devoted his time to nothing else, and as Mr. Grossbeck had unfortunately left me for a better position and Mr. Dickerson contemplated doing so, I sought another man afield, and thought I had found him in Mr. Ethelbert Withrod Stafford of Guelph College, Ontario, during the winter engaged with Professor Wash-

)urn at Minneapolis. He entered upon the duties of his position n February, and I started him at once upon the preliminary study)f the territory and of the material in hand.



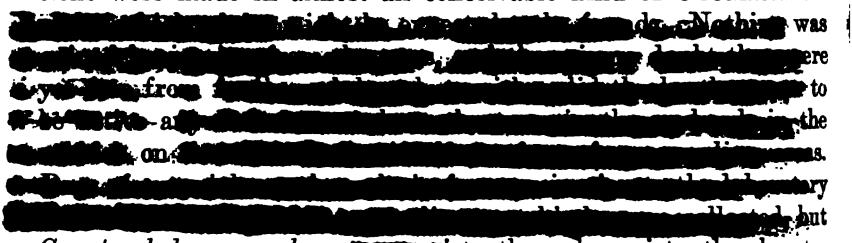
As early as February, 1911, the orchard at Vineland was looked)ver and the work to be done on it planned. It was then solid rosted up except for a little surface thawing in the middle of the lay, and the only chance that was thought to offer from the care- ul study of the literature that had been made, was an occasional ibernating adult. Such collections as were made, therefore, were)f deep clumps of leaves, of grass in deep ruts, of loose bark and he like, and when these proved barren, no serious disappointment vas felt.

Besides we had learnt that in 1910 there had been a distinct in- asion of this orchard from the outside, so that it might not be an ltogether unreasonable expectation that something of the sort night happen in 1911 as well.

Two days were spent in these woods and fields collecting, and as his was the first day of real field work, and I took a personal in- erest in both, what outfit Mr. Stafford took with him and what naterial he brought back, I think he got pretty well what the field fforded and about such species as could be expected in surface creen collecting.

March 7th, another collecting trip was made and more desperate fforts were made to surround the elusive insect. The bark was losely scraped away from orchard and other trees, the openings vere carefully examined and the gathered scrapings were sifted. Some of them were even carried on to New Brunswick. The eaves in the hedge rows were gathered and even swept up, and hese yielded a great lot of Rhynchophora, but no plum curculio.)ne specimen, however, was found, in leaf mold beneath an oak ree at about the surface of the sand. Unfortunately, this promis- ng lead was not followed up, for some reason.

The season holding cold no further collections were made until April 11th, and then all sorts of fruit trees were jarred, and collections were made in almost all conceivable kind of circumstances



Conotrachelus nenuphar

A trip to High Bridge a day or two later gave no other or different results; vegetation was not so far advanced and no beetles were seen at any point.

April 25th, peaches, pears and plums were again jarred without results at Vineland; but on April 29th one beetle was secured on the Experiment Orchard. A large number of other trees were jarred in other orchards during the day, and three additional beetles were obtained—two on peaches, one on plums. This record of four beetles as the result of a day's jarring work at Vineland, April 29th, marks the beginning of the curculio season for 1911, and a rather later opening than is usual for this species.

At Vineland there are two Experiment Orchards under Mr. Blake's charge, one of about 350 trees, the other somewhat smaller, which for our purposes do not differ very materially, and in only one of which really were any important observations made. The younger of these orchards was the one in which Mr. Stafford made most of his collections, and where he kept under very close observation 15 several groups of three trees each. Each of these groups was of one variety, one was left unsprayed, one received a self-boiled lime and sulphur with arsenate of lead, the other received the normal sprayings of the orchards.

Mr. Blake's reports are full in all cases concerning these sprayings, and the various tables given by Mr. Stafford give the dates of examinations made. I believe Mr. Stafford did his detailed work well and accurately. He did not always follow out what he was told to do, but what he did can be relied upon I think. The counts of ripened fruits were always made by Mr. Blake or one of his assistants.

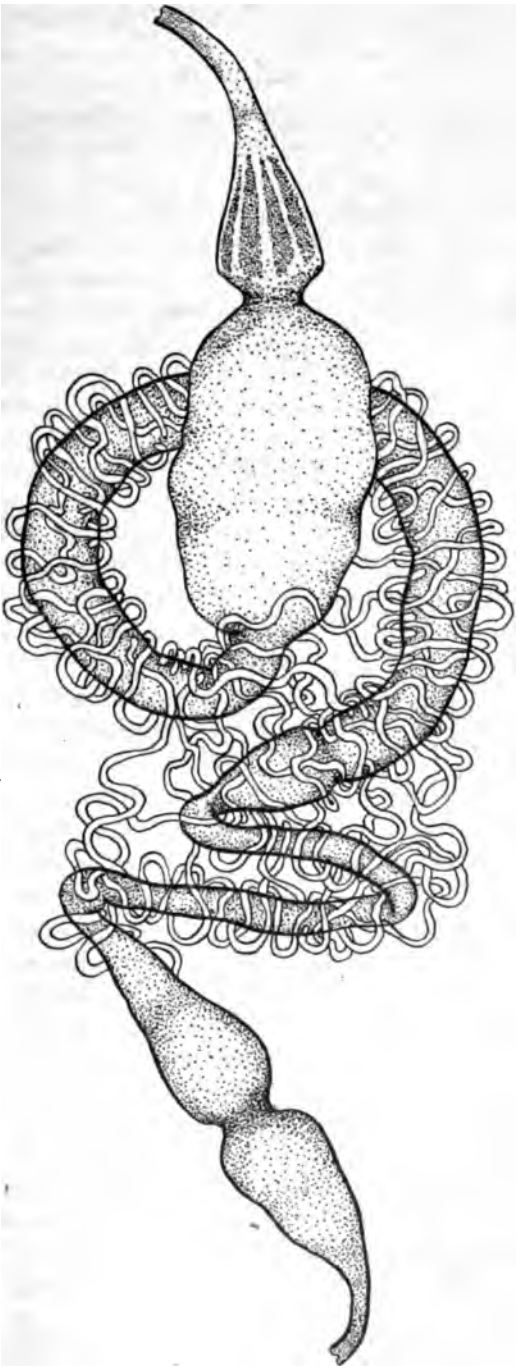


Figure 6.

Digestive system of Plum Curculio; very much enlarged.

The smaller orchard is one year older and furnished the supply made use of, chiefly, in 1910.

Under totally different conditions there is an Experiment Orchard on the Governor Voorhees farm at High Bridge, which was used by Mr. Blake as an addition and a check to work done at Vineland, but was resorted to by Mr. Stafford merely for purposes of comparison and not for additional information.

May 3d and 4th collections were made in orchards around Vineland; not a great many beetles were found anywhere, most of them around outside rows even in apple orchards, only isolated specimens in inside rows of peach orchards. Three pairs of beetles in copulation. Weather cold and windy, most peaches have shed petals, a few apple trees are in bloom, about one-half the plum petals have fallen.

May 5th, at High Bridge, peaches, apples, plums, pears and cherries were jarred, but no adult curculios were found on them at all. Nor were any hibernating adults found, sifting in woods at both sides of Experiment Orchard. Plums and cherries in full bloom, peaches coming into bloom, apples and pears swelling.

May 10th, beat twice around the Experiment Orchard and a few southern rows, also in interior. Got 22 beetles, 19 of them within three trees from edge of orchard. Beat pears to south and east of Experiment Orchard. On 3 of south side, got 8 curculios. Five southern—most on east side yielded 5, the twelve trees on the north yielded not one.

Mouth Structures.

The mouth structures of the plum curculio are small and little attention has been paid to them, but they are interesting, and they are in all respects functional. Since it has been shown that the insect even does a great deal of feeding, it behooves us to know that practically all kinds of surface and digging work is within their power. The mandibles are of the typical gouge shape, with two sharp and one flat inner tooth fitted for taking out surface layers of cells, situated at the end of the proboscis or rostrum and actuated by powerful tendons and levers extending well up the side of the head and hinged by a relatively powerful pin to the framework of the head itself.

Instead, therefore, of having rather a weakly developed mouth structure as is sometimes left to be inferred, the structure is really a very powerful one, and as far as mandibular work is concerned there is no sort of feeding on any kind of plant frequented by this insect which is beyond it.

On Plate 5, Figs. 2, 4, 5 and 6, the usual types of feeding on the surface of the leaf are shown, and these are for ordinary food work only. At Figs. 1 and 3, *a* and *b*, on the same plate, are illustrated peach buds and shoots also punctured for food, but in a different way. In both cases the feeding punctures penetrate deep into the plant tissue and tend to kill bud or shoot. They do not necessarily do so, but they may do so, and the feeding at that early period is to be considered a source of danger.

At 8 on Plate 8 is a normal feeding puncture on a fruit, while at 7 and 9 on the same plate are egg punctures with an egg unplaced and one placed to show the positions.

Inside the mandibles and so very materially smaller that they are completely concealed, are the soft fleshy maxilla, the inner lobes of which are hairy and furnished with soft spatulate processes; they are in no real sense assistants in the work to be accomplished by the mandibles.

So the small fleshy labium which lies almost concealed between the base of the maxilla are of little real functional use in the mouth structure.

We have become used to looking upon the Curculio as rather a sluggish insect, and perhaps with some sense of justice; but it certainly is not sluggish when it first makes its appearance in the orchards and on the trees. I had a series of specimens under almost continuous observations for several days, and their almost ceaseless activity was a source of constant surprise to me. To be sure they had just come out of hibernation, they were just copulating, they were just beginning to feed and really beginning to live, which may make a difference even in a Plum Curculio; but the activity was there and the rapidity of feeding. And the digestive system responded. The excretions came in strings and pellets, so that within 24 hours the full length of the digestive system must have been filled and emptied at least once. The digestive system, shown on page 471, is simple. The maceration of the food is chiefly done by the mandibles, but the mechanical condition is a little bettered by a series of diagonal chitinized

plates forming a small gizzard. This intense activity on the part of the adult curculio does not seem to last more than a few days at most. Perhaps it is only while the insect rouses from its winter nap, gets its alimentary canal filled and its vital functions in other directions started. When it is observed feeding in growing fruits there is certainly none of that nervous activity observable when it is feeding in buds, and then it clasps rather tightly, requiring somewhat of an effort to dislodge it.

Furthermore, it becomes worthy of notice that whereas at its first appearance, the matter of food is the principal one under investigation by the beetle, as the season advances the matter of food and of egg-laying is to an extent conjoined. Just how much those processes are altogether joined we do not yet know, and we have every reason to believe that there is considerable variation in the fruits and perhaps even in individual beetles. Certain it is that sometimes in counts made we will find feeding punctures only with remarkable uniformity, while in other cases it is rare to find a puncture not associated with an egg. Perhaps plums have fewer feeding punctures than other fruits, and peaches certainly have more feeding punctures comparatively than any other fruits known to me.

Apple feeding seems to be for nourishment and for oviposition in about even parts from my own experience. As a matter of fact while a female is laying eggs, I doubt whether she does any considerable amount of outside feeding, and a typical feeding puncture in an apple fruit, Plate 8, Fig. 8, is unlike an egg-puncture in a similar fruit—compare Figs. 7 and 9.

The egg crescent has been often enough described, but the average grower does not seem to understand its purpose nor its relation to the egg itself.

Two structures are really involved, the mouth parts to eat out a crescent-shaped flap and the ovipositor or egg-laying tube to put the egg into place. The egg of the Plum Curculio is really a very soft fragile structure which can stand little pressure of growth from young fruit.

The beetle, therefore, with its elegantly adapted mandibles gouges out in the plant tissue enough of the texture just below the surface of the skin to loosen a little flap and remove a pressure, like Figure 7 on Plate 8, which just shows the inner

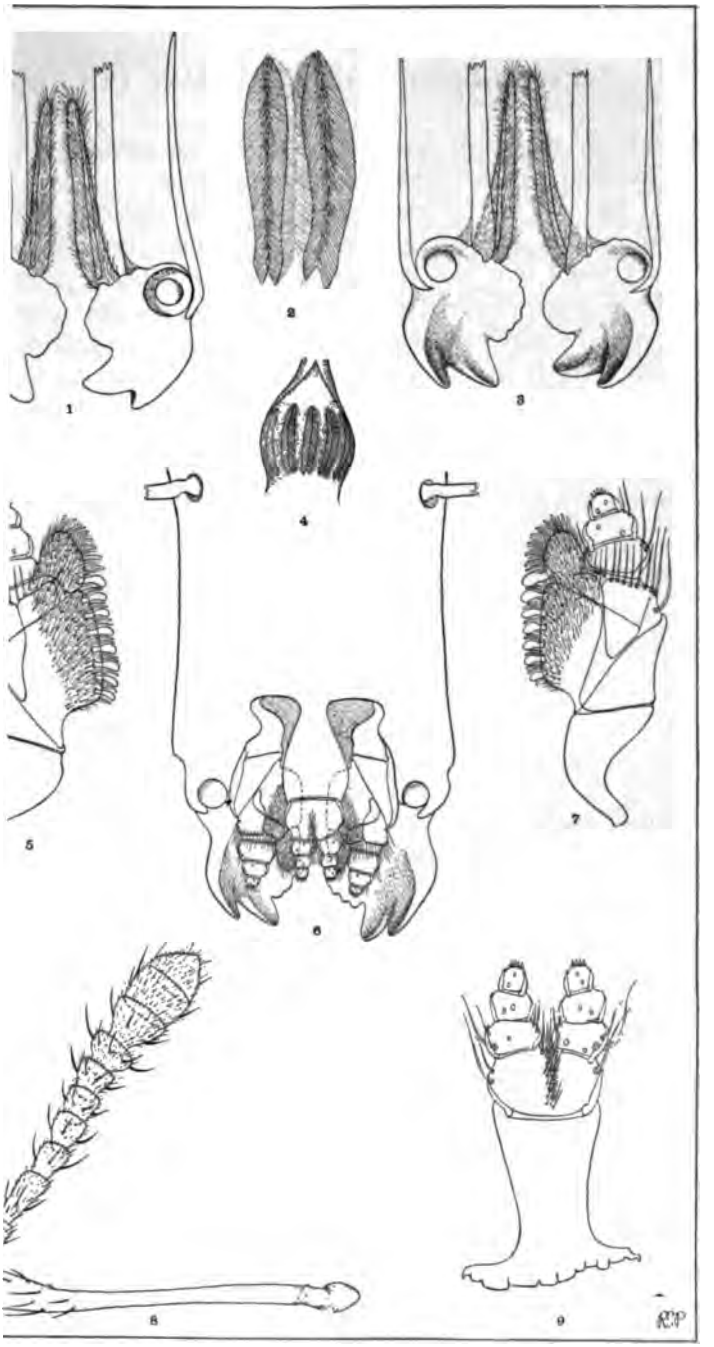


Figure 7.

ı Curculio; tip of rostrum from below showing the convex faces of the gouge-ıhaped mandibles from below.
thin diagonal series of plates found in the gizzard of the true digestive system ›n pl. 7, Fig. 4; very much enlarged.
ı Curculio; tip of rostrum from front, showing the concave cutting face and rouge-like structure. This structure suffices to shelter the remainder of the nouth parts and to equip the insect for its work in the orchard and on the trees. ard of the digestive system as a whole. Pl. —, Fig. 6.
ıxillæ of *Plum Curculio* adult from the right and left sides.
th parts of Plum Curculio in situ from front, showing all parts in relation to each *ther and in proportionate size.*
ıæ of Plum Curculio.
læ of Plum Curculio.

texture or cavity in section. That leaves outwardly just below the surface a little tough flap of skin tissue.

At the tail end of the body the female curculio has a rather broad, sharp, egg-laying tube or ovipositor. Seen under the ordinary hand lens this appears slightly roughened merely; seen under a high powered dissecting microscope, the upper surface is covered with little triangular plates like 4, 5 and 6, on Plate 8, and this is an ideal structure to force down into that little flap left by the mandibles. And as it is forced down and withdrawn it takes out just enough of that plant pulp remaining to make a comfortable opening for the curculio egg, without any pressure whatever. Plate 8, Fig. 9, shows the egg in position in a plum.

The Reproductive System.

The Plum Curculio produces a relatively large number of eggs over a considerable period of time by means of a small outfit of ovarian tubes. There are just two pairs, furnishing indeterminate numbers, nutritive material all at ends. There is no development in the summer or fall, and copulation takes place in April or early May. But from that period development is rapid, and 40 to 50 ova in various stages become normal in a healthy individual. I have not tested the capacity of a single female, but have seen thirty eggs daily recorded, which seems just a little difficult to credit when all the labor involved in laying them is considered.

The drawings supplied must be relied upon for further details on this point, which was not carried out in greater minutia, and so for the comparisons, which it was intended to make with the structures of related males.

May 11th, at High Bridge, 19 beetles were collected from the outer two rows of the experiment orchard, and other beetles were collected here as well, but always outside rows.

May 12th, peach and plum had shed their blooms on the College Farm, and apple blossoms were dropping. Beetles were obtained in small numbers from each of these trees. Again, on May 13th, collected 40 curculios around the edges of the orchards and none in the body of the orchard itself. Nor were beetles

found in possible hibernating quarters, just in places where they had recently come on for feeding and propagating purposes.

May 17th, went to Vineland, to old orchards from which shucks were falling generally, to collect material. Found beetles throughout the orchards now, but yet fewer in the center than around the edges. Found egg punctures now in some of the fruits and eggs in some of the punctures. At this time the trees to be examined in the peach orchard were selected out, and this particular feature of the work was especially looked after; the other work was left more or less discretionary with Mr. Stafford, and his records are in consequence rather vague. They do show, however, that he examined a large amount of fruit and foliage, determined that a very large amount of material was actually eaten by the curculio and that on plum and cherry practically all the fruit was destroyed or seriously injured. A sufficient record of this is also preserved at New Brunswick.

At this time no eggs at all were found in pears, few in apples and few in peaches, but more where the other fruits were considered; galleries in peaches could already be demonstrated in occasional specimens.

The first spraying of arsenate of lead only had been already made in the peach orchard on or about May 1st, omitting only the small series of trees collected as checks by Mr. Stafford. There is really a misunderstanding even here. Mr. Stafford claims that no check trees were left, and that every tree in this orcahrd received the arsenate of lead mixture. Mr. Blake's men, who did the actual work, deny this. They claim that this little series of 15 trees was left altogether unsprayed and received neither insecticide nor fungicide.

The second spraying was received May 17th and 18th, and consisted of arsenate of lead and self-boiled lime and sulphur, and a second series of 45 trees consists of trees so treated.

The third series is similar in number and received all the sprayings of the orchard. The first of arsenate of lead alone, the second combining the self-boiled mixture with arsenate of lead, the third forming the regular commercial mixture dealt out to the orchard at large, and concerning which Mr. Blake's record should be consulted; in fact, except as to the records of drops themselves and as to the details of insect experiments, Mr. Blake's records must dominate.

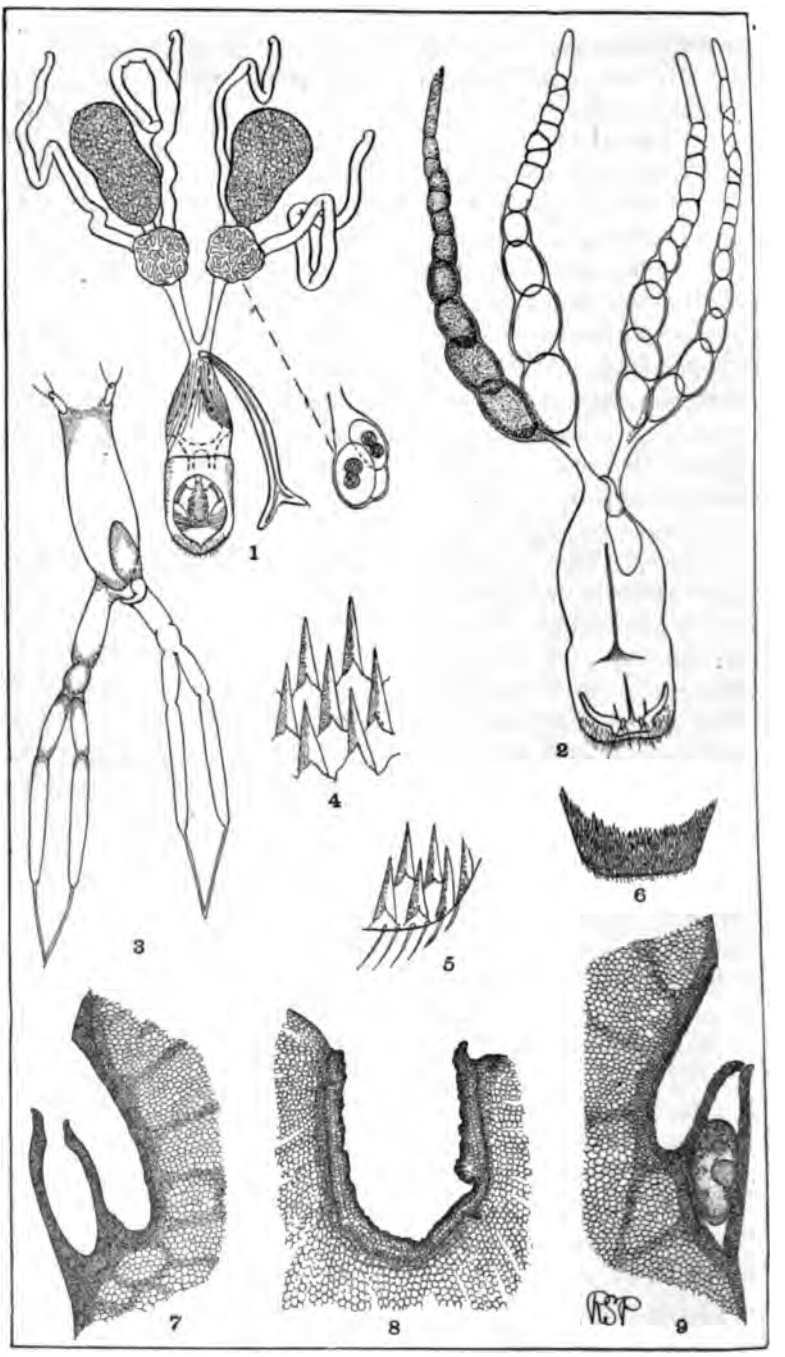


Figure 8.

FIGURE 8.

1. Male reproductive system, much enlarged, showing the genital hook posteriorly, the spermatophores separated.
2. Female reproductive system in process of development, ova partly developed in the tubes and the oviduct developed to its full size: armature of tip partly developed. These individuals have fed and have begun their growth.
3. Female reproductive system not yet developed: ovairum tubes with individual ovaries not separating into eggs. These individuals have just made their appearance on the trees and have begun to feed. The receptaculum seminis is closely applied to the oviduct at the junction of the vagina, and the capsule is clearly made out as it is also on Fig. 2.
4. Flat cutting processes, on the tip of the oviduct, very much enlarged: as they appear on the surface.
5. The cutting processes or teeth as they appear along the edge of the oviduct.
6. Tip of the ovipositor of Plum Curculio showing the recurved teeth under a moderate enlargement. The ovipositor is of full width, but not full length.
7. Incisions made in fruit by Plum Curculio to receive and protect egg. The inner deeper incision is cut with the mouth parts and separates a considerable segment of tissue. The outer excavation has been made with the ovipositor and is just the pressure of that structure close to the skin of the fruit and the withdrawal of the fruit tissue on the flattened teeth—the manner in which the egg is left in the tissue is shown at 9.
8. A normal feeding puncture of a Plum Curculio—in transverse section and much enlarged.
9. Completed egg puncture of Plum Curculio, with egg in position.

May 23d, found 28 beetles on outside rows at High Bridge and only two on inside rows. Out of a dozen selected for dissection, 7 were females, and they averaged a little over 40 eggs approaching maturity.

May 29th, the first systematic count of fallen fruit was made for the season, including 12 Altons, 24 Elbertas and 9 Crawfords. Also two Carmans and two Hileys. With each of the three former varieties—I am now quoting Stafford—three methods of spraying were tried, namely, first, no arsenate of lead in any spray but only the fungicide. Second, one arsenical treatment at time shucks were falling. Third, an arsenical spray in addition to above applied when flower buds were not yet open, or in short two arsenical sprays. The second arsenical spray was applied with self-boiled lime and sulphur. One Carman and one Hiley received only the early arsenical spray. The remaining two received both. Detailed results will be found in the tabular reports of this experiment. Thus far from Mr. Stafford's notes have been given that his tabulated results may have all the light to which his own convictions entitle them.

In the examinations made all the eggs seem to have hatched, and from every hatched egg a curculio gallery developed. Nor does there seem to have been any feeding other than for egg punctures. This does not mean that such conditions did not exist; it simply means that for some reason Mr. Stafford got his counts or material mixed, and that all that can be determined from his data is that during the last days of May and early days of June there was a perfectly enormous lot of drops from the young orchard trees. In fact he has himself summarized the total as over 6,000, and that 2,614 or more of these were clean, free from either curculio or rot. As the season advanced the injuries from the curculios lessened as might have been expected and injury from rot intensified. And while injury from rot and curculio were very generally associated in the beginning, the injury from the rot became more intensified and more aggravated as the season advanced. In any event, there could be no further claim that beetles were not plentiful enough in the orchards, though Elberta, Alton and Crawford in the order named were perhaps the favorites this year. Last year the Carman enjoyed the distinction.

June 12th, when the drops were counted for the third time atters were complicated by the rose-bugs which were present in ge numbers, by the undoubted effect of the drought and by the neral demoralized condition of the breeding areas everywhere, e to the intense dry weather.

At this time the curculio larvæ in fruits everywhere were approaching full size and as it was my desire to breed out a lot of ecimens under all sorts of orchard conditions, a lot of breeding rs were already in use and I instructed Mr. Stafford to build ne breeding frames, approximately two feet square, of 3-inch de, ½-inch thick stuff. These could be loosely covered with eesecloth to keep out undersirable inhabitants and the surface uld be crowded with curculio larvæ that could be kept under sy superficial observation. Some frequently stirred, some alwed to remain quiet and others dealt with in various methods at might occur to us. It would give us a large lot of specimens good condition, with little trouble, at any rate.

The nine cages were well made and ideally placed. As deribed I could find no fault of any kind, and each cage was stocked ith about three quarts of infested fruit. The larvæ in one lot ere counted, made out to be approximately 400 and I was willg to accept two cages so stocked as a source of information. me days afterward, when I asked for further knowledge, I was et with excuses and explanations, and finally with the statement at all the insects had yielded to a uniform and irresistible grouch id had abandoned all my nice cages. I got no beetles at all, and orst of all, no information.

Worst of all, the insects seemed to have taken a violent dislike Mr. Ethelbert Withrod Stafford, and they positively refused pupate or otherwise play in his yard or in any place where ey could find any way of getting out.

The fourth count of dropped fruits was made June 19th, and e number of rotted fruits as compared with curculio injured uits now stands out very strongly. The injury at this time is of cessity almost confined to the Elberta. It is notable also that ie application of arsenates is lessening the number of curculio jury alone, and is not so much controlling the number of rotting uits. That is due in part also to a practical discontinuance of ie source of injury; for after June 20th, there is little new feedig by curculios, while rot continues to come blithely in. It is

due also, in part, to the effectiveness of the insecticide applications which undoubtedly do exercise a continuing effect where the fungicide application thus does not exercise such a continuous attack and sometimes is, indeed relatively imperfect when the maximum effect is demanded from it.

It has been pointed out that there is a little over-lapping of broods; that the first lot of summer curculios is already on the wing when the fag end of the spring brood is practically done; some of these new beetles undoubtedly allow themselves to be tempted by the beauties of a delicately perfect Carman or Elberta and will gnaw a hole into such a fruit to its damage and such a fruit, of course, has no coating of poison. If one or more of the disreputable survivors is in the way, the matter is much simpler and the feeding will be more extensive and more disreputable; but in either case the feeding is really an accident. The old beetle should have been killed off weeks before; the new beetle should not have been allowed to develop.

Yet Mr. Blake's most serious fault, as shown by his own records, is the very high amount of fruit shown injured at Elberta picking time. It may not be so bad when reduced to a percentage or when put to the test of the orchard record as a whole; but it does not fit well into a record which has little of anything else to recommend it.

Mr. Blake's Curculio Record on Elbertas.

lot.	Treatment.	Free.	Slightly Marked.	Badly Marked.
7	Unsprayed	8	28	40
7	Sprayed once	33	37	28
7	Sprayed twice	103	60	55
8	Unsprayed	17	57	60
8	Sprayed once	66	59	39
8	Sprayed twice	120	103	42
9	Unsprayed	1	1	4
9	Sprayed once	16	7	31
9	Sprayed twice	7	5	13
0	Unsprayed	1	4	20*
0	Sprayed once	0	1	5*
0	Sprayed twice	3	2	10*
1	Unsprayed	8	37	56
1	Sprayed once	9	34	20
1	Sprayed twice	5	24	15
2	Unsprayed	0	10	28
2	Sprayed once	18	41	22
2	Sprayed twice	64	80	51
3	Unsprayed	23	83	116
3	Sprayed once	103	186	129
3	Sprayed twice	95	166	84
4	Unsprayed	2	14	34
4	Sprayed once	4	22	36
4	Sprayed twice	11	27	51

* Part of crop lost.

MR. BLAKE'S RECORDS.

Belle of Georgia.

ORCHARD No. 1.

Sprayed once	Free from Curculio marks	113
	Slightly marked	228
	Badly marked	377
Sprayed twice	Free from Curculio marks	264
	Slightly marked	407
	Badly marked	220

ALL SPRAYS, COLLECTED MAY 29TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
5–4	Crawford	7	3	4	4	4	2	2	2	.....	.....	4
11–4	"	5	.....	5	5	5	2	3	3	.....	.....	3
17–4	"	4	.....	4	4	4	3	1	1	.....	.....	1
6–5	Elberta	25	10	15	15	15	13	2	2	.....	.....	2
11–5	"	17	12	5	5	5	3	2	.....	2	.....	2
17–5	"	53	23	30	29	29	15	14	14	.....	1	15
23–5	"	31	18	13	12	12	11	1	1	.....	1	2
6–11	"	37	25	12	12	12	9	3	3	.....	.....	3
11–11	"	16	16	.....	.....	.....	.....	.....	.....	.....	.....	.....
17–11	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23–11	"	21	5	16	16	16	8	8	8	.....	.....	8
6–16	Alton	113	98	15	15	15	12	3	3	.....	.....	3
11–16	"	74	58	16	15	15	11	4	4	.....	1	5
17–16	"	42	42	.....	.....	.....	.....	.....	.....	.....	.....	.....
23–16	"	2	.....	2	2	2	2	.....	.....	.....	.....	.....
	Total	447	310	137	134	134	91	43	41	2	3	48

SPRAYED WITH ARSENATE OF LEAD AND SELF-BOILED, COLLECTED MAY 29TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
4–4	Crawford	2	.....	2	2	2	1	1	1	.....	.....	1
10–4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16–4	"	3	.....	3	3	3	2	1	1	.....	.....	1
4–5	Elberta	44	18	26	26	26	18	8	8	.....	.....	8
10–5	"	43	11	32	26	26	20	6	4	2	.....	6
16–5	"	51	23	28	28	28	7	21	16	5	.....	21
22–5	"	48	27	21	21	21	14	7	7	.....	.....	7
4–11	"	42	12	30	30	30	25	5	5	.....	.....	5
10–11	"	2	1	1	1	1	1	.....	.....	.....	.....	.....
16–11	"	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
22–11	"	8	.....	8	8	8	6	.....	2	.....	.....	2
4–16	Alton	122	82	40	38	38	27	11	9	2	2	13
10–16	"	96	78	18	18	18	11	7	4	3	.....	7
16–16	"	28	19	9	9	9	5	4	4	.....	.....	4
22–16	"	53	18	35	28	28	15	13	13	.....	2	15

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3-4	Crawford	4	.....	4	4	4	2	2	2	.....	.....	2
9-4	"	1	.....	1	1	1	1	.....	.....	.....	.....	.....
15-4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3-5	Elberta	99	38	61	59	59	42	17	17	.....	2	19
9-5	"	45	20	25	25	25	15	10	10	.....	.....	10
15-5	"	61	31	30	30	30	11	19	19	.....	.....	19
21-5	"	42	27	15	15	15	5	10	10	.....	.....	10
3-11	"	17	2	15	15	15	11	4	2	2	.....	4
9-11	"	17	10	7	7	7	5	2	2	.....	.....	2
15-11	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21-11	"	7	3	4	3	3	2	1	1	.....	1	2
3-16	Alton	157	103	54	54	54	47	7	7	.....	.....	7
9-16	"	33	33	.....	.....	.....	.....	.....	.....	.....	.....	.....
15-16	"	10	10	.....	.....	.....	.....	.....	.....	.....	.....	.....
21-16	"	86	44	42	42	42	29	13	13	.....	.....	13
	Total	579	321	258	255	255	170	85	83	2	3	88

CHECK, COLLECTED JUNE 5TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3-4	Crawford	16	1	15	15	15	.....	9	6	6	.....	.....	6
9-4	"	9	.....	9	9	9	.....	5	4	3	1	.....	4
15-4	"	2	.....	2	2	2	.....	2	.....	.....	.....	.....	.....
3-5	Elberta	131	10	121	119	119	.....	79	40	37	3	2	42
9-5	"	94	5	89	81	81	.....	61	20	14	6	8	28
15-5	"	127	24	103	91	91	.....	84	7	4	3	12	19
21-5	"	154	18	136	119	119	.....	96	23	20	3	17	40
3-11	"	64	6	58	56	56	.....	34	22	22	.....	2	24
9-11	"	67	1	66	63	63	.....	54	9	9	.....	3	12
15-11	"	30	2	28	28	28	.....	26	2	2	.....	.....	2
21-11	"	23	2	21	19	19	.....	17	2	2	.....	2	4
3-16	Alton	119	11	108	100	100	.....	69	31	19	12	8	39
9-16	"	20	10	10	7	7	.....	6	1	1	.....	3	4
15-16	"	2	.....	2	2	2	.....	2	.....	.....	.....	.....	.....
21-16	"	39	13	26	21	21	.....	19	3	3	.....	4	7
	Total	897	103	794	732	732	.....	563	170	142	28	61	231

SPRAYED WITH ARSENATE OF LEAD AND SELF-BOILED, COLLECTED JUNE 5TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
4-4	Crawford	7	4	3	3	3	.....	2	1	1	.....	.....	1
10-4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16-4	"	1	.....	1	1	1	.....	1	.....	.....	.....	.....	.....
4-5	Elberta	81	12	69	68	68	.....	58	10	10	.....	1	11
10-5	"	62	5	57	56	56	.....	39	17	15	2	1	18
16-5	"	117	28	89	80	80	.....	69	11	7	4	9	20
22-5	"	76	13	63	55	55	.....	54	1	.....	1	8	9
4-11	"	29	3	6	25	25	.....	22	3	3	.....	1	4
10-11	"	4	.....	4	3	3	.....	3	.....	.....	.....	1	1
16-11	"	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22-11	"	7	2	5	3	3	.....	3	.....	.....	.....	2	2
4-16	Alton	133	30	103	99	99	.....	95	4	4	.....	4	8
10-16	"	18	8	10	8	8	.....	7	1	1	.....	2	3
16-16	"	21	12	9	9	9	.....	7	2	1	1	.....	2
22-16	"	21	3	18	15	15	.....	14	1	1	.....	3	4
	Total	578	120	457	425	425	.....	374	51	43	8	32	83

ALL SPRAYS, COLLECTED JUNE 5TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
5-4	Crawford	8	1	7	7	7	.....	6	1	1	.....	.....	1
11-4	"	6	.....	6	6	6	.....	5	1	.....	1	.....	1
17-4	"	27	.....	27	27	27	.....	27	.....	.....	.....	.....	.....
5-4	Elberta	43	4	39	39	39	.....	36	3	3	.....	.....	3
11-5	"	52	5	47	47	47	.....	31	16	10	6	.....	16
17-5	"	168	78	95	82	82	.....	75	7	7	.....	13	20
23-5	"	53	16	37	28	28	.....	25	3	3	.....	9	12
5-11	"	50	44	15	15	15	.....	13	2	2	.....	.....	2
11-11	"	12	8	9	9	9	.....	9	.....	.....	.....	.....	.....
17-11	"	9	2	7	2	2	.....	2	.....	.....	.....	.....	.....
23-11	"	19	9	10	7	7	.....	7	.....	.....	.....	5	5
5-16	Alton	80	47	33	31	31	.....	29	2	2	.....	3	3
11-16	"	13	3	10	6	6	.....	[illegible]	[illegible]	[illegible]	.....	2	4

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3–4	Crawford	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9–4	"	5	.....	5	5	5	.....	5	.....	.....	.....	.....	.....
15–4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3–5	Elberta	55	9	16	36	36	.....	30	6	6	.....	10	16
9–5	"	32	5	27	25	25	.....	23	2	2	.....	2	4
15–5	"	60	32	28	9	9	.....	8	1	1	.....	19	20
21–5	"	47	20	27	12	12	.....	9	3	3	.....	15	18
3–11	"	26	7	19	17	17	.....	14	3	3	.....	2	5
9–11	"	31	7	24	17	17	.....	17	.....	.....	.....	7	7
15–11	"	2	.....	2	2	2	.....	2	.....	.....	.....	.....	.....
21–11	"	11	2	9	3	3	.....	3	.....	.....	.....	6	6
3–16	Alton	34	17	17	14	14	.....	7	7	2	5	3	10
9–16	"	17	16	1	.....	.....	.....	.....	.....	.....	.....	1	1
15–16	"	8	7	1	.....	.....	.....	.....	.....	.....	.....	1	1
21–16	"	44	25	19	10	10	.....	9	1	1	.....	9	10
	Total	372	147	225	150	150	.....	127	23	18	5	75	98

ARSENATE OF LEAD WITH SELF-BOILED, COLLECTED JUNE 12TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot. Alone.	Total Rot.
4–4	Crawford	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10–4	"	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16–4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4–5	Elberta	25	4	21	17	17	.....	16	1	1	.....	4	5
10–5	"	11	3	8	2	2	.....	2	.....	.....	.....	6	6
16–5	"	81	59	22	5	5	.....	5	.....	.....	.....	17	17
22–5	"	51	25	26	8	8	.....	7	1	1	.....	18	19
4–11	"	22	7	15	11	11	.....	11	.....	.....	.....	4	4
10–11	"	10	6	4	1	1	.....	1	.....	.....	.....	3	3
16–11	"	5	3	2	.....	.....	.....	.....	.....	.....	.....	2	2
22–11	"	10	8	2	.....	.....	.....	.....	.....	.....	.....	2	2
4–16	Alton	27	23	4	2	2	.....	2	.....	.....	.....	2	2
10–16	"	30	24	6	4	4	.....	4	.....	.....	.....	.....	.....
16–16	"	9	8	1	.....	.....	.....	.....	.....	.....	.....	1	1
22–16	"	18	17	1	.....	.....	.....	.....	.....	.....	.....	1	1
	Total	300	188	112	50	50	.....	48	2	2	.....	60	62

ALL SPRAYS, COLLECTED JUNE 12TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
5-4	Crawford	1	.....	1	1	1	.....	1	.....	.....	.....	.....	.....
11-4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17-4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5-5	Elberta	12	7	5	5	5	.....	5	.....	.....	.....	.....	.....
11-5	"	13	6	7	3	3	.....	3	.....	.....	.....	4	4
17-5	"	79	56	23	6	6	.....	6	.....	.....	.....	17	17
23-5	"	64	41	23	7	7	.....	5	2	2	.....	16	18
5-11	"	28	25	3	1	1	.....	1	.....	.....	.....	2	2
11-11	"	18	13	5	.....	.....	.....	.....	.....	.....	.....	5	5
17-11	"	18	17	1	.....	.....	.....	.....	.....	.....	.....	1	1
23-11	"	31	27	4	.....	.....	.....	.....	.....	.....	.....	4	4
5-16	Alton	55	51	4	3	3	.....	2	1	1	.....	1	2
11-16	"	21	21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17-16	"	3	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23-16	"	5	4	1	.....	.....	.....	.....	.....	.....	.....	1	1
	Total	348	271	77	26	26	.....	23	3	3	.....	51	54

ALL SPRAYS, COLLECTED JUNE 19TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot. Alone.	Total Rot.
5-4	Crawford	5	3	2	.....	.....	.....	.....	.....	.....	.....	2	2
11-4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17-4	"	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5-5	Elberta	9	6	3	2	.....	2	2	.....	.....	.....	1	1
11-5	"	16	9	7	3	.....	3	3	.....	.....	.....	4	4
17-5	"	78	52	26	3	.....	3	3	.....	.....	.....	23	23
23-5	"	45	21	24	5	.....	5	5	.....	.....	.....	19	19
5-11	"	29	23	6	3	.....	3	3	.....	.....	.....	3	3
11-11	"	70	54	16	6	1	5	6	.....	.....	.....	10	10
17-11	"	23	14	9	3	.....	3	3	.....	.....	.....	6	6
23-11	"	23	12	11	2	.....	2	2	.....	.....	.....	9	9
5-16	Alton	16	11	5	1	.....	1	1	.....	.....	.....	4	4
11-16	"	9	5	4	.....	.....	.....	.....	.....	.....	.....	4	4
[illegible]	"	[illegible]	[illegible]	1	.....	.....	.....	.....	.....	.....	.....	1	1

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3-4	Crawford												
9-4	"												
15-4	"	1		1	1	1		1					
3-5	Elberta	21	4	17	12	6	6	8	4	4		5	9
9-5	"	8	3	5	4		4					1	1
15-5	"	29	16	13	5	1	4	5				8	8
21-5	"	11	2	9	6	1	5	6				3	3
3-11	"	1		1	1	1		1					
9-11	"	11	2	9	6	2	4	6				3	3
15-11	"	6		6	4		4	3	1	1		2	3
21-11	"	8		8	6	1	5	6				2	2
3-16	Alton	4	3	1								1	1
9-16	"	10	2	8	2		2					6	6
15-16	"	3	3										
21-16	"	2	1	1	1		1	1					
	Total	115	36	79	48	13	35	37	5	5		31	36

ARSENATE OF LEAD WITH SELF-BOILED, COLLECTED JUNE 19TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot. Alone.	Total Rot.
4-4	Crawford												
10-4	"	1	1										
16-4	"												
4-5	Elberta	9	6	3								3	3
10-5	"	13	5	8	3	1	2	3				5	5
16-5	"	69	53	16	1	1		1				15	15
22-5	"	22	12	10	4	1	3	4				6	6
4-11	"	12	7	5	3	2	1	3				2	2
10-11	"	35	20	15								15	15
16-11	"	6	5	1	1	1		1					
22-11	"	12	8	4	3		3	3				1	1
4-16	Alton	18	8	10	2	2						8	8
10-16	"	17	9	8	2		2	2				6	6
16-16	"	11	10	1								1	1
22-16	"	7	7										
	Total	232	151	81	19	8	11	17				62	62

CHECK, COLLECTED JUNE 26TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3–4	Crawford	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9–4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15–4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3–5	Elberta	11	1	10	8	4	4	5	3	.....	3	2	5
9–5	"	7	2	5	3	.....	3	3	.....	.....	.....	2	2
15–5	"	15	3	12	7	1	6	7	.....	.....	.....	5	5
21–5	"	8	1	7	5	3	5	4	1	.....	1	2	3
3–11	"	2	.....	2	2	.....	2	1	1	.....	1	.....	1
9–11	"	14	6	8	8	1	7	7	1	.....	1	.....	1
15–11	"	7	2	5	5	.....	5	4	1	.....	1	.....	1
21–11	"	4	.....	4	2	.....	2	2	.....	.....	.....	2	2
3–16	Alton	7	2	5	4	3	1	3	1	1	.....	1	2
9–16	"	8	4	4	3	3	.....	3	.....	.....	.....	1	1
15–16	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21–16	"	2	.....	2	1	.....	1	.....	1	.....	1	1	2
	Total	85	21	64	48	15	36	39	9	1	8	15	25

ARSENATE OF LEAD WITH SELF-BOILED, COLLECTED JUNE 26TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
4–4	Crawford	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10–4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16–4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4–5	Elberta	4	.....	4	2	.....	2	1	1	1	.....	2	3
10–5	"	4	3	1	1	.....	1	.....	1	.....	1	.....	1
16–5	"	21	7	14	8	4	4	7	1	1	.....	6	7
22–5	"	9	2	7	7	2	5	5	2	1	1	.....	2
4–11	"	2	1	1	.....	.....	.....	.....	.....	.....	.....	1	1
10–11	"	12	6	6	2	.....	2	2	.....	.....	.....	4	4
16–11	"	3	1	2	.....	.....	.....	.....	.....	.....	.....	2	2
22–11	"	8	4	4	2	1	1	2	.....	.....	.....	2	2
4–16	Alton	12	5	7	3	3	.....	1	2	2	.....	4	6
	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
5–4	Crawford	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
11–4	"	2	1	1	1	.....	1	.....	1	.....	1	.....	1
17–4	"	1	.....	1	1	1	1	1	.....	.....	.....	.....	.....
5–5	Elberta	35	29	6	.....	.....	.....	.....	.....	.....	.....	6	6
11–5	"	9	5	4	.....	.....	.....	.....	.....	.....	.....	4	4
17–5	"	25	11	14	5	.....	5	5	.....	.....	.....	9	9
23–5	"	17	9	8	7	1	6	6	1	1	.....	1	2
6–11	"	13	12	1	1	.....	1	1	.....	.....	.....	.....	.....
11–11	"	33	21	12	1	1	.....	1	.....	.....	.....	11	11
17–11	"	15	8	7	2	.....	2	2	.....	.....	.....	5	5
23–11	"	13	6	7	5	.....	5	3	2	.....	2	2	4
6–16	Alton	6	1	5	1	.....	1	1	.....	.....	.....	3	3
11–16	"	1	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1
17–16	"	1	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1
23–16	"	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	172	104	68	14	3	22	20	4	1	3	43	47

CHECK, COLLECTED JULY 10TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3–4	Crawford	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9–4	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15–4	"	1	.....	1	1	1	.....	.....	1	.....	1	.....	1
3–5	Elberta	2	.....	2	1	.....	1	1	.....	.....	.....	1	1
9–5	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15–5	"	3	.....	3	1	1	.....	1	.....	.....	.....	2	2
21–5	"	1	.....	1	1	.....	1	1	1	.....	1	.....	1
3–11	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9–11	"	1	.....	1	1	.....	1	.....	1	1	.....	.....	1
15–11	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21–11	"	1	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1
3–16	Alton	6	1	5	3	2	1	2	1	.....	1	2	3
9–16	"	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15–16	"	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21–16	"	1	.....	1	1	1	1	.....	.....	.....	.....	.....	.....
	Total	19	4	15	9	5	5	5	4	1	3	6	10

ARSENATE OF LEAD WITH SELF-BOILED, COLLECTED JULY 10TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
4–4	Crawford												
10–4	"												
16–4	"												
4–5	Elberta												
10–5	"												
16–5	"	2	1	1								1	1
22–5	"												
4–11	"												
10–11	"	1	1										
16–11	"												
22–11	"												
4–16	Alton	8	4	4	4	4		4					
10–16	"	8	6	2	1		1	1				1	1
16–16	"	4	4										
22–16	"												
	Total	23	16	7	5	4	1	5				2	2

ALL SPRAYS, COLLECTED JULY 10TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
5–4	Crawford												
11–4	"												
17–4	"	1	1									1	1
6–5	Elberta	2	1	1								1	1
11–5	"												
17–5	"	1	1										
23–5	"	1		1	1		1		1		1		1
6–11	"												
11–11	"	2		2	1		1	1				1	1
17–11	"												
23–11	"	1	1										
6–16	Alton	8	3	5	5	5		5					
11–16	"	1		1								1	1
17–16	"	1	1										
	"												

CHECK, COLLECTED JULY 24TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3–5	Elberta	14	1	13	11	.....	11	6	5	.....	5	2	7
3–11	"	12	2	10	10	.....	10	4	6	.....	6	.....	6
9–5	"	20	.....	20	19	.....	19	5	14	.....	14	1	15
9–11	"	8	1	7	5	.....	5	2	3	.....	3	2	5
15–5	"	20	.....	20	19	.....	19	7	12	.....	12	1	13
15–11	"	24	5	19	14	.....	14	13	1	.....	1	5	6
21–5	"	21	1	20	14	.....	14	4	10	.....	10	6	16
21–11	"	7	.....	7	5	.....	5	4	1	.....	1	2	3
	Total	126	10	116	97	.....	97	45	52	.....	52	19	71

ARSENATE OF LEAD WITH SELF-BOILED, COLLECTED JULY 24TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
4–5	Elberta	33	1	32	17	.....	17	9	8	.....	8	15	23
4–11	"	29	8	21	5	1	4	3	1	.....	1	16	17
10–5	"	32	4	28	16	.....	16	6	10	.....	10	12	22
10–11	"	35	11	24	15	.....	15	8	7	.....	7	9	16
16–5	"	22	3	19	13	.....	13	6	7	.....	7	6	13
16–11	"	30	5	25	10	.....	10	3	7	.....	7	15	22
22–5	"	22	1	21	14	.....	14	7	7	.....	7	7	14
22–11	"	17	5	12	9	.....	9	4	5	.....	5	3	8
	Total	220	38	182	99	1	98	46	52	.....	52	93	135

ALL SPRAYS, COLLECTED JULY 24TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
6–5	Elberta	6	2	4	3	.....	3	3	.....	.....	3	1	4
6–11	"	25	8	17	4	.....	4	3	1	.....	1	13	14
11–5	"	9	.....	9	5	.....	5	3	2	.....	2	3	5
11–11	"	49	12	37	19	.....	19	14	5	.....	5	18	23
17–5	"	17	3	14	12	.....	14	6	6	.....	6	2	8
17–11	"	38	5	33	24	.....	24	19	5	.....	5	9	14
23–5	"	4	.....	4	4	.....	4	1	3	.....	3	.....	3
23–11	"	9	2	7	3	.....	3	3	.....	.....	.....	4	4
	Total	157	32	125	74	.....	76	52	22	.....	25	50	75

VINELAND TOTALS.

CHECK TREES.

Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
May 29	579	321	258	255	255	.....	170	85	83	2	3	88
June 5	897	103	794	732	732	.....	563	170	142	28	61	231
June 12	372	147	225	150	150	.....	127	23	18	5	75	98
June 19	115	36	79	48	13	35	37	5	5	.....	31	36
June 26	85	21	64	48	15	33	39	9	1	8	16	25
July 10	19	4	15	9	5	5	5	4	1	3	6	10
Total	2,067	632	1,435	1,242	1,170	76	941	296	250	46	192	488
Extra Drops	126	10	116	97	.....	97	45	52	.....	52	19	71
Total	2,193	642	1,551	1,339	1,170	173	986	348	250	98	211	559

ALL THE ORCHARD SPRAYS.

Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
May 29	447	310	137	134	134	.....	91	43	41	2	3	48
June 5	568	216	352	305	305	.....	270	36	29	7	37	73
June 12	348	271	77	26	26	.....	23	3	3	.....	51	54
June 19	340	226	114	28	1	27	28	.....	.....	.....	86	86
June 26	172	104	68	14	3	22	20	4	1	3	43	47
July 10	18	7	11	7	5	2	6	1	.....	1	4	5
Total	1,893	1,134	759	514	474	51	447	87	74	13	224	313
Extra Drops	157	32	125	74	.....	76	52	22	.....	25	50	75
Total	2,050	1,166	884	588	474	127	499	109	74	38	274	198

HILEY, SPRAYED ONCE WITH ARSENATE OF LEAD.

No.	Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
26-6	June 6	367	196	171	107	107	.....	93	14	14	.....	64	78
26-6	June 13	193	158	35	3	3	.....	3	.....	.....	.....	32	32
26-6	June 19	132	81	51	19	2	17	17	2	2	.....	32	34
26-6	June 27	16	10	6	5	.....	5	5	.....	.....	.....	1	1
26-6	July 10	163	74	89	80	.....	80	79	1	.....	1	9	10
26-6	July 24	18	5	13	5	.....	5	1	4	.....	4	8	12
	Total	889	524	365	219	112	107	198	21	16	5	146	167

HILEY, SPRAYED TWICE WITH ARSENATE OF LEAD.

No.	Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
26-7	June 6	183	88	95	79	79	.....	58	21	21	.....	16	37
26-7	June 13	134	115	19	8	8	.....	7	1	1	.....	11	2
26-7	June 19	60	30	30	5	2	3	5	.....	.....	.....	25	25
26-7	June 27	13	7	6	3	.....	3	3	.....	.....	.....	3	3
26-7	July 10	101	39	62	49	5	44	46	3	.....	3	13	16
26-7	July 24	42	5	37	15	.....	15	1	14	.....	14	22	36
	Total ...	533	284	249	159	94	65	120	39	22	17	90	119

CARMEN, SPRAYED TWICE WITH ARSENATE OF LEAD.

No.	Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
25-7	June 6	75	25	50	43	43	.....	38	5	5	.....	4	9
25-7	June 13	145	126	19	3	3	.....	3	.....	.....	.....	16	16
25-7	June 19	64	34	30	13	.....	13	13	.....	.....	.....	17	17
25-7	June 27	13	7	6	4	.....	4	2	2	.....	2	2	4
25-7	July 10	130	47	83	81	.....	81	81	.....	.....	.....	2	2
25-7	July 24	1	.....	1	1	.....	1	1	.....	.....	.....	.....	.....
	Total ...	428	239	189	145	46	99	138	7	5	2	41	48

CARMEN, SPRAYED ONCE WITH ARSENATE OF LEAD.

No.	Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
25–6	June 6	173	54	119	103	103	.....	90	13	12	1	16	29
25–6	June 13	202	159	43	6	6	.....	5	1	1	.....	37	38
25–6	June 19	111	46	65	29	1	28	29	.....	.....	.....	36	36
25–6	June 27	17	10	7	6	.....	6	5	1	.....	1	1	2
25–6	July 10	76	21	55	54	.....	54	51	3	.....	3	1	4
	Total ...	579	290	289	198	110	88	180	18	13	5	91	109

SPRAYED WITH ARSENATE AND SELF-BOILED MIXTURE.

Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
May 29	543	290	221	233	233	.....	147	84	74	12	14	100
June 5	578	120	457	425	425	.....	374	51	43	8	32	83
June 12	300	188	112	50	50	.....	48	2	2	.....	60	62
June 19	232	151	81	19	8	11	17	.....	.....	.....	62	62
June 26	84	33	51	26	11	15	19	7	5	2	25	32
July 10	23	16	7	5	4	1	5	.....	.....	.....	2	2
Total	1,760	798	929	758	731	27	610	144	124	22	195	341
Extra Drops	220	38	182	99	1	98	46	52	.....	52	83	135
Total	1,980	836	1,111	857	732	125	656	196	124	74	278	476

NOTE.—All drops were thought to be over, when an extreme drought caused a number of Elbertas in our experiment to drop. These are therefore added here to complete the results.

Remedial Measures.

It might seem that after a season of observational and experimental failure the outcome of definite knowledge relating to destructive and remedial measures must be correspondingly small. But that does not really follow. The observations made, were definite enough, even though some of the factors were unintended or unexpected, and there were additional applications and observations made in other orchards that help out very materially the recorded mess. The applications recorded by Mr. Blake and his assistants in the orchards in his charge at Vineland, New Brunswick and High Bridge, have all been taken into consideration and the observations made by Mr. Dickerson, Mr. Weiss and myself, chiefly during the early part of the season in the commercial peach and other orchards, all have been drawn upon in deciding upon the recommendations to be made.

Speaking, primarily, to peach growers, they have, in the State of New Jersey the easiest task of all horticulturists as against the Plum Curculio, provided they will recognize their obligation to maintain a modern orchard so far as planting, treatment and general handling is concerned. Larvæ do not develop well in peaches, nor do they come to maturity at all freely under the normal conditions of a cultivated orchard. It would be too much to say that no larvæ develop in such an orchard—it is fair to say that there are very few that do so. The heavy end of the infestation comes into the peach orchard from the outside, early in the season, and hungry for feeding supply.

Observation has shown quite a little seasonal difference in the appearance of the insects; but, ordinarily, the feeding beetles begin to appear when the blossoms begin to open, and a thorough dose of arsenate of lead just then should get those early feeders before copulation and before sexual maturity. Weather conditions should determine whether a week or ten-day limit should be fixed for the second spraying; but I should put it a week under normal circumstances and might add a fungicide if I were fighting early rot. The later sprayings in a peach orchard have usually the plant disease end in view, but I should recommend the continued addition of arsenate of lead so long as active feeding is observed by the curculio. I should not attempt to reach the abnormal feedings of the exceptional examples of the second brood.

The chief points to be kept in mind in the summer treatment of a peach orchard is to keep the surface as clean and dry as possible and the trees themselves free from unnecessary loose bark, moss or other shelter. It does not seem to be necessary to gather up and destroy the early drops at any time, and only in a wet season would it prove desirable to do anything with the larger later drops. Then they certainly should *not be* cultivated under. They should either be raked up and destroyed or they should be exposed to the full action of the hot sun so as to get a toughening of the fruit.

In the plum and cherry orchard matters are much more serious. There is no doubt that the insect gets in here earlier, no doubt that the larva hatches and develops in the growing fruit, and no doubt either that it is able to reach so advanced a stage in the fruit that it is ready to enter from the decaying mess directly into the moistened soil beneath.

There is much difference between cherry varieties as to susceptibility to curculio attack. I have two trees of early Richmond which almost never have a curculio, but one tree of another variety is badly attacked.

So there is considerable difference between plums, but the differences have not forced themselves upon me, and I would not, from my own observations, recommend any differences between plum varieties.

Jarring is eminently the remedial measure in a plum orchard where it can be promptly and economically carried out. Jarring gets the early beetles and the importance of dealing with these has been sufficiently pointed out. Jarring gets also all the drops, and the importance of getting these and destroying them cannot be over-estimated. I would not allow any plum drop to remain in my orchard over 24 hours after it was more than half grown if I could prevent it, and I would keep a man or boy at work continuously picking them up and destroying them if I had no other way of getting at them.

I should begin arsenical spraying at once as soon as there was a beetle found on the tree, and I should keep the new growth consistently and persistently covered with arsenate of lead so as to kill off as many of the adults as possible. I should use 1 pound of arsenate of lead (Vreeland's Electro) in 20 gallons of water,

or its equivalent in other brands at same strength, and I should add ½ a gallon of glucose to part of the water.

In the apple orchard I should fight curculio as hard as anywhere else, and I should expect to get as good although perhaps not as striking reports and results.

Apples, and especially the later varieties, do not show much damage from feeding punctures as a rule, but almost every grower, and certainly every student, has seen the weird cripples that are sometimes produced by excessive feeding.

But there is no doubt that in New Jersey the apple, and especially the more or less neglected apple, has become the nursery for the Plum Curculio, and that the logical point of attack against the latter insect is the apple orchard.

It is in the apple orchard that conditions of temperature and moisture most favor the insect, and it is in the apple that the greatest number of specimens can best come to maturity and develop, and it is in the apple that the insect is able to maintain itself for the longest period of time in the early larval stages. Furthermore, after the apple has dropped to the ground the curculio larva is almost safe, and a dozen or more may develop to full growth within a single fruit in a ferment or decay mixture which does not in any way harm or interfere with it.

The owner of every apple tree and apple orchard owes it to every plum, cherry and peach grower to deal with his apple orchard and trees as against the Plum Curculio, even if he suffers no loss which he traces to it directly; and it will not even be a very expensive proceeding.

Picking up and destroying, *not cultivating,* any dropped fruits is one of the most effective measures in the apple orchard. There is not and cannot be any development in or on the fruit while on the tree, hence there would have to be a period of at least a week in the fruit on the ground before the curculio larva could reach any size, and the collection and destruction of dropped apple fruits in an orchard or under a neglected tree would mean the coincident destruction of thousands of curculio larvæ. The picking up and destroying may be done by men, cattle, sheep or hogs and the only requirement is that it be thorough.

If spraying is to be relied upon, early sprayings with arsenate are necessary, and these will reach as well the bud moth and various leaf-miners as the curculios. The buds on apple come late,

and a large part of the leaf-feeding by the curculio is done on the leaves. To the man who sprays with both insecticides and fungicides to obtain apples which under modern classifications rank first class, we have little more to give as advice. He finds the cleanest kind of clean culture necessary for his results. To the orchardist who has not heretofore realized his duty to his fellow, I suggest that he spray his apple orchard thoroughly as soon as it gets into full leaf with arsenate of lead, 20 per cent. at the rate of 1 pound in 20 gallons of water, or if a lower grade of arsenate of lead is used, with an equivalent strength, and cover as thoroughly as possible.

The second spraying may be that for the Codling Moth, and the third should come in about a week after the second.

After that the looking after the dropped fruits becomes the most important matter and should get the careful attention of the orchardist.

PORT ON THE MOSQUITO WORK FOR 1911.

ORT ON THE MOSQUITO WORK FOR 1911.

By JOHN B. SMITH, Sc.D.

Legislature that met in January, 1910, provided in its nental bill for ten thousand dollars ($10,000) to become le in April of that year, and for fifteen thousand dollars 00) to become available in its regular bill in November of ar. The Report for 1910 is just off the press in time to ı account of the expenditures made out of that supple- bill. The report of expenditures made out of the regular ginning November 1st, 1911, are shown in the present bill are those made out of the supplemental bill beginning May 11, and which became available for use about that time gislation passed during the spring session of 1911.
annual statement of drained area now is:

	Acres.	Feet of Ditching.
907, as reported	15,851	2,215,524
as reported	6,669	888,650
as reported	2,672	360,800
as reported	4,650	350,000
as hereafter	8,528	712,000
	38,370	4,528,974

vailable $25,000 00

CONTRACTS.

	Acres.	Feet Ditches.	Contractor.	Cost.	
Township....	3,000	280,000	Manahan	$7,000	
Township....	1,728	270,000	Manahan	6,000	
	4,728	550,000			13,000 00
					$12,000 00

AGREEMENTS.

Locality.	Contractor.	New Area. Acres.	New. Ditches.	Cost.	
Jersey City	Manahan	....	.....	$200	
Elizabeth	Reitter	....	2,000	400	
Maple Island	Manahan	100	4,000	900	
Waverly	Manahan	....	3,000	700	
Kearny	Manahan	300	3,000	600	
Kearny	Manahan	600	1,500	900	
Kearny	Manahan	300	500	600	
Kearny	Dupont Powder Co.	100	.....	95	
Brick Tp.	Manahan	800	40,000	935	
Dover Tp., north	Manahan	800	45,000	850	
Dover Tp., south	Manahan	800	40,000	850	
					7,130 00
		3,800	162,000		
					$19,130 00

REPAIR AND CLEANING.

Linden repairs and cleaning	$125 00	
Tremley Points repairs and cleaning	25 00	
Elizabeth cleaning work	300 00	
Elizabethport	40 00	
Manasquan	30 00	
		520 00
		$19,650 00

Appropriation	$25,000 00
Payments in contracts and agreements	19,650 00
Expenses and incidentals	$5,350 00

Under the head of expenses and incidentals come all those outlays for advertising, supervision, traveling expenses and red-tape generally, as well as the salaries for those engaged in the work. At the present time the executive officer and Mr. Herman H. Brehme are the only officers on full pay. Miss Meske is getting nothing for her services specifically on the mosquito work. Mr. Henry H. Brehme is on half pay and helped out by the members of the local boards of health, and Mr. Walter S. Abbott resigned from the office to accept a position with the State Entomologist of Illinois.

There is no doubt that there must be some modification of the work done in the State. It is scientifically correct, or would be if it could be carried out as originally planned. But it did

not keep in mind the special needs of cities or towns nor the almost impossibility of moving the average municipal office or officeholder. The usefulness of Mr. Henry H. Brehme to the Extermination League has proved most highly suggestive, and has induced a modification of the character of the report. On the other hand, the original lines on which this work was proposed have justified themselves even more strikingly, and the reports presented by Mr. Henry H. Brehme are most suggestive.

As reports continue to come in from government and other authorities in the tropics it appears that much of our New Jersey information has approved itself elsewhere, and that we have a right to stand by our own conclusions in many instances even when not apparently in line with the original conclusions of the physician, soldier, board of health worker. I was for a time seriously considering the matter of abandoning altogether the fresh water work of the department, and it was really only the realization of how general the two problems are yet united in the Hudson county district that led me to the other extreme of giving more and better help than ever before.

THE CITY, TOWN AND VILLAGE PROBLEM.

The primary object of the State work with mosquitoes in New Jersey is dealing with the migratory or salt marsh mosquitoes that breed in the waste, uninhabited areas near the shore and fly in enormous swarms to cities, towns, villages and other inhabited places, often many miles away. Against these such localities are helpless, and they have a fair claim upon the State to demand that relief which is beyond their own power to afford.

But besides these species there are others, even more annoying, fully as aggressive, actually more dangerous from the sanitary point of view, almost or quite as abundant at many points, which are bred right at home, where they make themselves a nuisance. There is no puddle so small, so well concealed, so dirty, so prominent, that it will not breed mosquitoes of some kind, and some kinds are appropriately known for that reason as "house mosquitoes."

So long as the salt marsh mosquitoes remained dominant, local work would not make much of a show and was not waged nor en-

couraged by me; indeed one or two abortive campaigns started before this phase of the problem was fully understood, did much to discredit mosquito work in the State; but since these salt marsh forms have been reduced to insignificant factors throughout a large area, the local species have assumed their proper importance. And this importance is really very much greater than was supposed and the problem greater than the local authorities were prepared to meet.

The individual health officers of the municipalities in Hudson, Essex and Union counties soon realized their helplessness, and a Conference Committee on Mosquitoes was organized under the auspices of the Newark board of health. I have on previous occasions found reason to commend the advanced position taken by this board and the aid and facilities that it has given to other boards in their work.

This conference committee accomplished a great deal in spreading information among the boards of health and health officers, and in the years following great progress was made in securing information. But as information was obtained the problem seemed to become ever more formidable, for there seemed to be no end to the places where or conditions under which mosquitoes would breed. Besides, the communities as a rule did not support their health boards properly and some of the health boards did not back up their officers.

Hudson county has a county board of health, and made a progressive step by appointing Mr. William Delaney as mosquito officer for the county at an adequate salary. The Newark board of health appointed an inspector with two permanent assistants and a number of temporary ones to look after the problem within its limits, and other municipalities took more or less half-hearted measures to improve conditions within their limits.

This was helped somewhat by inspections made by my office, and demonstrates that as matters then stood the matter was no longer one for the State, but for each locality.

During the latter part of 1910 the "North Jersey Mosquito Extermination League" with "Headquarters Newark Board of Health Office" came into being. This is "An organization devoted to the extermination of the mosquito on co-operative lines," of which Mr. John W. Dobbins, of Newark, is president; Mr. Joseph F. Lynch, of Harrison, is vice president, and Dr. G. Herbert Tay-

lor, of Maplewood, is secretary and treasurer. Meetings are held on the third Monday of each month and have been well attended during the existence of the organization.

Representatives from Hudson, Bergen, Passaic, Essex, Union and Morris counties are included in the membership, and reports are made every month of progress made.

From the beginning my office has co-operated with this association, and throughout the summer I had in service Mr. Henry H. Brehme, whose duty was to keep continuously under observation the territory covered by the league, to notify the various officials concerned of danger points, and to act in an advisory capacity generally.

First and foremost, to give all the members of the league and the various health officers a basis for their application to their local authorities, I had enlarged maps made of the more dangerous localities, or those containing the more obvious swampy, low, springy or other wet areas that produced mosquitoes, and especially *Anopheles* species in large quantities. All the choked brooks were included in these maps and our field experience for years past was utilized in their preparation. These field maps were turned over to Mr. Herman H. Brehme, my assistant since this work began, and during the winter and very early spring months he went over every foot of ground with the maps, marked out all the known breeding areas and made a concise description of each, together with the means to be taken for temporary improvement and final abatement.

These field maps were reproduced on tracing cloth and duplicated on blue prints, while the reports were duplicated in typewritten copies.

At the league meetings these blue prints and reports were distributed and an effort was made to furnish at least one copy of each to every municipality concerned. Usually the health officer received a copy, sometimes the board as well, and occasionally the mayor manifested sufficient interest to ask for information.

Every municipality therefore started with a stock of local information, and before Mr. Henry H. Brehme went into service on April 1st, 1911, his brother, Mr. Herman H. Brehme, went over the entire territory with him and not only posted him as to the known breeding areas but as to the suspected points to be kept under more or less constant observation.

To estimate the value of this assistance or the results of the work done by the various members of the league in their official positions is almost beyond reasonable possibility. It may seem as if mosquitoes had been as abundant and as annoying as ever during the summer of 1911, but as a matter of fact that was nowhere the case. The flights and swarms of half a dozen years ago are of the past and nothing like it was found anywhere. That there were a great many mosquitoes in some localities, that they were exceedingly annoying, and that they might even be reasonably called a pest in some place is undoubtedly true, and the explanation is clearly enough brought out in the following series of special reports prepared by Mr. Henry H. Brehme for the various localities.

Messrs. Dobbins, Delaney and Richards tell their own story, and I invite especial attention to Mr. Dobbins's story.

We have in the area under consideration one that is fast building up. In which natural drainages are ruthlessly cut without considering results. Areas nearly laid out; some sewered, some with cesspools, some with city water, some with cisterns. New buildings going up with excavations often lying idle for weeks. Factories with receptacles of all kind, necessary and unnecessary, and an unparalleled number of small industries in which water is required, and where stagnant water is accepted as a matter of course. I have been with Mr. Dobbins walking through a city street and had him pause at an open yard door—"Let's step in here for a minute and see what we find"—and have had him point out an old bath-tub set up in one corner with a gallon or two of water and a big brood of wrigglers. This is the city or local problem and that is the particular feature of the problem for which no sufficient appropriation has been made.

North Arlington.

A series of five or six holes along the water main of the Arlington Water Company, which is located north of the Belleville turnpike, opposite the Arlington cemetery. The holes are on property of the water company and should be filled. It would cost only a small sum ($5–$6) to do it and the breeding places would then be permanently done away with.

June 13th, *Culex pipiens* was found breeding there and the

health board was notified. June 17th, breeding was again found there in company with Health Officer Edward O'Hara and Dr. J. A. Exton, and they were fully advised as to what should be done. June 23d, breeding went on as before and the Newark men oiled the place to kill off the larvæ.

July 29th, August 26th and September 18th, inspections were made, the breeding places still exist unchanged at the end of the summer and are in exactly the same condition for 1912 that they were for 1911. It cost more to inspect and treat these holes in 1911 than it would have done to fill them!

A breeding pool was found June 13th, on the north side of Belleville turnpike, opposite the Arlington cemetery, about 5,000 square feet in extent. *Pipiens* larvæ were developing in the pool and it was determined that filling would be best here because it was too low to drain into meadow creek. The ownership was in doubt and filling would have cost about $150.

June 17th, showed this place to Dr. Exton and Mr. O'Hara, and told them it should be oiled until filling could be enforced.

June 23d, the Newark city force oiled this pool and killed off the mosquito broods then in it.

July 29th, August 26th and September 18th, inspections were made in this same section. At no time was any work done there by the North Arlington authorities, and at the end of the season the conditions are in exactly the same shape that they were at the beginning.

It is now determined that the property belongs to the cemetery authorities, and the probabilities are that something practical will be done before another season opens.

In the Catholic cemetery, located on the west side of Schuyler avenue, about half a mile north of Belleville turnpike, are several swampy places on which some *pipiens* breeding was found June 17th, and which were pointed out to Dr. Exton and Health Officer O'Hara with the recommendation that the place be drained.

June 23d, the owners had men at work digging ditches and no more breeding was found. Conditions were found good July 29th, August 26th and September 18th, and all these drained places were safe. A brood of *C. sylvestris* was on the wing, but that had come out of the woodland pools formed by the heavy rains early in the month.

Conditions here have been materially improved during the sea-

son of 1911. The cemetery authorities have expended about $300, and have given in addition about $200 worth of hay in return for work done.

The Meacham tract is located on the west side of Kearny avenue, about three-quarters of a mile north of Belleville turnpike, and on it I found, June 17th, a dirty swamp 600 x 300 feet, with a good brood of *pipiens,* larvæ and pupæ. It is the largest and worst breeder in North Arlington and I recommended that it be drained and, until then, oiled.

June 23d I found *Anopheles* also breeding on this territory and the Newark city force covered it with oil to kill off the brood. The owners were notified and urged to take action.

July 29th, I found that ditches had been run into the brook to the north and that there had been some recent oiling, so that no breeding was found. So, on August 29th and September 18th, the place was free from breeding and mosquito safe. This area also has been permanently improved during the season of 1911.

Arlington.

April 15th, an inspection in this town located as the principal danger points for *pipiens* the series of pools along the edge of the meadow between the New York and Greenwood Lake railroad and the Arlington cemetery.

This territory should be eventually filled or drained to make it safe, but the authorities were notified that oiling would answer as a makeshift. August 29th, the pools were found oil covered, and during the season they were intermittently treated, but there is no doubt that a great many mosquitoes bred here, and no improvement has been made in the conditions.

Harrison.

Mr. John Lynch is inspector here, and ready enough to do all within his power; unfortunately he gets little backing from his board, and, as a matter of fact, most of the work done in Harrison was done by the employes of the Newark board of health under the direction of Mr. Dobbins.

A nasty place for *pipiens* breeding is a stretch of about 200

feet along the edge of the dumping ground on the south side of Warren street, between Manor avenue and Seventh street. Breeding in great quantity was found here May 3d, June 7th, July 8th, August 8th, 12th, and September 8th—really all season; and so far as I am aware nothing at all was done to check it. The number of specimens bred here for general distribution is beyond estimate.

The so-called Lamp-black swamp is an area of about 150 x 100 feet, used as a dumping ground, and located along the main line of the Pennsylvania railroad, between Fourth street and the Passaic river. This is perhaps the most prolific breeding place in Harrison, and brood after brood came out in almost continuous succession. The Newark authorities put on oil on several occasions and checked the mill for a few days at a time, but it was never more than the most temporary kind of check, and the place is a disgrace to a civilized community.

On grounds of the Worthington Pump Works, between Warren and Sussex streets, is a stretch of about 150 feet, more or less water filled, and in which *pipiens* were found from time to time during the summer. Oil was used at times, and at no period were matters found to be very bad, but the place should be filled and permanently done away with.

Late in the season a surface pool developed on the south side of Sussex street, between Worthington street and Manor avenue, in which a brood of *pipiens* developed. This is a matter for surface grading, and one of those places that becomes dangerous only during a period of heavy rains with a heavy brood of mosquitoes ready to take advantage of every temporary opportunity.

Belleville.

Mr. W. Brand Smith is inspector in this town, and all within his power was done to better conditions.

May 24th, two large *pipiens* breeding ponds were located in Hillside Park. They were pointed out to the owner, taken in hand immediately and eliminated before the end of June.

April 21st, a strip of 200 feet along the River road, facing dump at the foot of Little street, was located as a breeding ground. It was examined again May 11th, 24th, June 27th, July 27th and September 21st, and as a rule was found oiled and com-

paratively free from wrigglers. There is no doubt that some mosquitoes got out here, however, and, although dumping and filling continued throughout the season, conditions are not much better than they were at the beginning, and the same work must be carried on next season as well.

April 21st, an area of about 20,000 square feet of swamp was located on the east side of River road, and it was advised that this be made safe by draining into the Passaic river at an expense of about $25. Nothing was done, however, and while some of the broods developing here were killed off by oil a very great many mosquitoes bred here and the place is just as bad as ever and will require just as much attention in 1912 as it did in 1911.

There is a swampy area about 150 x 300 feet on the west side of the River road, opposite the old Newark Water Works, which is a bad breeding place, yet cannot be easily dealt with. It is being settled by owners of small plots who are putting in ditches which have no outlets and can have none, and are cultivating the land between for vegetables. Some small houses are also going up and the area is in process of improvement and settlement. The application of oil on these ditches is vigorously resisted by the owners who claim it hurts their crops. There is no sewer, and for the present the place has been left as a breeder.

There is quite a large swampy acreage on property of the East Jersey Water Company, on which both *pipiens* and *Anopheles* breeding were found after midsummer. Some oiling was done and the broods were in part killed off, and a large ditch had been cut, in September, on the southern end of the property, taking off some of the water. Matters will be somewhat better, therefore, in 1912 than they were in 1911.

A pool about 3,000 square feet on the north side of Chestnut street, west of Passaic avenue, bred *pipiens* throughout the season, and after mid-summer *Anopheles* as well. It is formed by surface drainage and should have been graded out of existence. It was merely oiled occasionally and is as bad as ever.

There is a large swamp covering many acres located near the isolation hospital and that undoubtedly breeds the spring species and probably *sylvestris* as well. Its place as a breeder of summer species has not been determined, and, in any case, this is a matter of county ownership and for county action.

In addition, Belleville suffers from the barrel, tub and cess-

pool nuisance, 16 barrels and tubs being located and dealt with in one afternoon by Mr. Brehme on a house to house inspection with Mr. Smith.

Kearny.

The Kearny problem as based upon the Franck's creek sewer conditions, and the salt marsh locations, are elsewhere fully set out and the experimental and other work is fully detailed. Dr. James A. Exton is health officer and Mr. Albert E. Geissler is inspector, and both of these have co-operated to the extent of their ability in the fresh-water problem—for Kearny has a serious fresh-water problem—as well as in the salt marsh work.

First of all there are numerous catch-basins, cesspools, tubs, barrels and other receptacles throughout the town which demanded attention and received very little, for the most part breeding mosquitoes unrestrictedly throughout the season.

There is a dumping ground along the edge of the meadow, east of Schuyler avenue, north of the Erie railroad, where mosquitoes bred freely throughout the summer. A number of broods were killed off by Mr. Geissler with oil; but at best this was a mitigation only and conditions otherwise are just as bad now as they were at the beginning of the season.

Another dumping ground is located where the Bergen avenue sewer flows into the meadow east of Schuyler avenue, and this is also a perennial breeding place which Mr. Geissler dealt with as best he could from time to time.

Three other dumping grounds are located between Franck's creek and the New York and Greenwood Lake railroad, and these were handled or neglected in the same way.

An ugly place is where the Tappen street sewer comes out into the meadow, and spreads over it because there is no other place to go. Some oil was used here; but the task was so obviously hopeless with the facilities at hand that nothing more than half-hearted work was done.

Another sewerage pool, dependent upon Franck's creek condition, is near the Kearny Gun Club, east of Schuyler avenue, and nothing practical was accomplished here.

West of Kearny avenue, between Bergen and Woodland avenues woodland species were found breeding as early as April 15th,

and *sylvestris* bred here throughout the season. Some of them were killed off by oil, but the majority of them carried through.

Breeding pools were located early in the season at Hickory and Pine streets, and the corner of Quincy and Schuyler avenues. These were promptly filled and constitute almost the sum total of permanent work done by the municipality.

At the present time Kearny has the distinction of being by all odds the worst mosquito breeding area for its size, within the limits of northeastern New Jersey, taking in the salt and fresh water species together, and the solution of the problem is in the hands of the municipal authorities—a sanitary problem of the most important character, affecting not only the health of their own but of the neighboring communities.

Bloomfield.

The health inspector of this town is Dr. J. C. Saile, active enough and perfectly competent; but with absolutely no backing in his municipality and working entirely without encouragement.

A great provider is an area 300 x 100 feet south of the Erie railroad and east of Orchard street. It belongs to a florist and could easily be filled at small expense. Brood after brood, literally millions of individuals, developed here, and while Dr. Saile put on oil occasionally, when notified by Mr. Brehme, not much good was accomplished and the breeding place still exists, virulent as ever. This is essentially one of those cases for which the Duffield amendment was prepared.

A swamp in the Brookdale section, 150 x 350 feet, was found breeding both *Anopheles* and *pipiens,* as early as June 2d. Filling began in this area during the latter part of June, and was continued more or less constantly during the summer, so that by the end of the season the breeding area had been much contracted. Some oiling was done also, and a few broods were killed off in this way, but a goodly supply of specimens, nevertheless, emerged here during the season. It is probable that by another year this area will be entirely eliminated.

A large breeding pool is located on the north side of the Erie railroad, about 300 feet east of the Orchard street station. It was kept oiled throughout the season and few if any mosquitoes

developed; but it still exists for 1912. Five or six loads of ashes would put it out of existence absolutely and permanently.

Along Second river there is a swampy area that breeds woodland species in spring, and this is now in process of filling. It is not a serious source of trouble in any case.

In the Second river itself, on the north side, at Montgomery and Willet streets, there is a dead, overgrown area in which *Anopheles* and *pipiens* breed merrily and nothing is done to keep the flow of the stream unimpeded during seasons of low water.

Bloomfield is a dirty town as to back yards with numerous barrels and other receptacles as well as worse conditions, and its supply of mosquitoes during the season has been continuous and abundant; enough for its own use, with plenty left over for its neighbors.

Whatever improvements have occurred in the mosquito situation, cannot be fairly charged against the official body that might normally be responsible for them.

Glen Ridge.

Mr. Frederick D. Bell is the active member of this board in mosquito work, and Mr. H. H. Benson is inspector. Both of these gentlemen accompanied Mr. Brehme, April 28th, on a tour of inspection in which a few dangerous places were pointed out, but only one actual breeder, on east side of Ridgewood road, was found.

June 21st, a spring breeding *Anopheles* was located, but no other open breeding place was found during the season, and no breeding was discovered in factories or barrels. The town was kept almost absolutely free from open or visible breeding areas, nevertheless there were mosquitoes enough to be troublesome at all times.

The Kearny salt marsh invasions were, of course, shared with the neighboring municipalities; some of the locals came from the adjacent areas, but perhaps the bulk of the house trouble came from the cesspools which were a great deal more numerous and more dangerous than was appreciated early in the season. Glen Ridge deserves commendation for its work during the summer.

Orange.

Orange, so far as natural conditions is concerned, has few bad breeding places, and Health Officer J. Scott McNutt looked after these, in general, in a satisfactory way. So far as the back yard, sewer basin or housework is concerned, nothing was done in any way by my office.

A small swampy area at the southeast corner of Central avenue and South Jefferson street was found to be a *pipiens* breeding area in early summer, and that was promptly abated by filling.

The Rahway river, on the other hand, was allowed to get into all sorts of bad condition throughout the town, and after midsummer bred *Anopheles* continuously and unchecked. There seems to be some unwritten law that under no circumstances must any one do anything to improve the condition of this unfortunate stream!

South Orange.

The work in South Orange is in charge of Dr. A. C. Benedict, and is perhaps more thoroughly systematized than that in any other neighboring community. Very few natural breeding places remain, and as fast as one is formed or located proceedings are taken to abolish it.

Even the Rahway river receives some attention here, and only in mid-August was a brood of *Anopheles* and *pipiens* located in the village limits.

What may be termed the individual breeding places are the principal sources of trouble here, and in a house to house inspection made by Mr. Henry Brehme with Dr. Benedict, on July 7th, quite a number of tubs, barrels and a breeding cesspool were located, each of them supplying a small vicinage. As one establishment alone furnished 10 breeding tubs, the number of specimens in the supply was not altogether inappreciable.

East Orange.

Dr. R. H. Hunt is health officer here, and gave a demonstration of what could be done with the reasonable backing of the board and a reasonable sum of money to expend. East Orange's

record in the past has not been of the best; it would have been hard to better it in 1911.

The brook from Halstead street and Rhode Island avenue flowing southeast and south into the brook that crosses South Orange avenue, in the Vailsburg section of Newark, has always been a bad breeder, and notice of its condition was given May 1st. It was cleaned out for its entire course, kept under observation, and only once during the season, September 19th, were larvæ of any kind observed at any point. While some mosquitoes did undoubtedly escape, the number was insignificant in proportion to what would normally have developed.

Another similar stream coming from Central avenue and flowing south to South Orange and Grand avenue, in the Vailsburg section, was of a similar character, and was treated in the same way. It was thoroughly cleaned late in May, was oiled for its full length on four several occasions, and at no time were wrigglers of any kind found in it during the season.

A little brook flows through a swampy area on the south side of Willcox avenue, opposite Whittlesey avenue, and this was a known danger point. The brook was cleaned out and kept clean, the swampy area was partially filled so that no water lodged during the season, and while it is still a danger area for a wet season it is under easy control and can be completely eliminated without much additional trouble and expense.

A swampy area, 100 x 150 feet, is located on the north side of Elmwood avenue, between Park and Oak streets. Early woodland species were found here May 1st, and *sylvestris* and others occurred from time to time later in the season. Considerable filling was done here during the summer, and the place is in process of improvement. Nevertheless some mosquitoes did get out here during the summer.

Another swampy area about 200 x 150 feet is on the south side of Rhode Island avenue, opposite Elmwood Park, and that required ditching, filling and oiling. *Pipiens* breeding began here in June, and drainage work was also begun at the same time. Breeding continued until late in August, but filling was also started at the western end so that by early September this, the largest and worst breeding area in East Orange, was practically safe. Work must be continued, however, until this area is com-

pletely filled or drained, which should be easily accomplished during the winter.

On the southwest corner of Tremont avenue and South Clinton street is a considerable pool which was oiled several times during the season, but which nevertheless bred out several considerable broods of mosquitoes. It requires only three or four loads of dirt to fill it permanently, and why it was left as it was during the summer lacks explanation.

On the south side of Rhode Island avenue, west of where the Rhode Island avenue swamp is being filled in, a large pool was located, September 19th, which contained the largest brood of *pipiens* larva seen in East Orange during the season. The matter was taken in hand at once and oil was applied, and oil must be applied from time to time until this filling is completed, but with ordinary precautions this need not become a danger area.

East Orange has shown what can be done where natural conditions are decidedly bad. She is not freer than her neighbors from back yard and other breeding, and on July 20th Mr. Henry Brehme assisted Dr. Hunt in locating a number of pest holes, notably cellar excavations containing water, of which there seem to be an unusual number in town. On these points, however, I have no further knowledge and no criticisms to offer.

West Orange.

Dr. J. Minor Maghee is health officer here and gets little or no official backing in his fight.

A *pipiens* breeding pool was found as early as June 1st, on the west side of the Valley road, opposite Carey street, and the authorities were advised to either drain into the Rahway river or fill with from seven to eight loads of dirt. Nothing was done throughout the season and up to September 11th, large broods of larvæ were found in the pool and certainly hatched, providing a comfortable fall brood and a hibernating supply.

A dirty brook that comes from Gregory avenue, and flows south into the Rahway river, was noted as early as the end of April and again, as a danger point, June 1st. Nothing was done and by mid-August there was a large brood of *Anopheles* larvæ on deck which also were left to develop unchecked. By September 11th large broods of *Anopheles* and *pipiens* were present, the brook was

in as bad or worse condition than ever and the fall and winter supply was provided for.

The Rahway river forms the boundary between West Orange and Orange, and as usual received no attention. Its condition was bad as early as April 22d. Twice attention was called to it in June, and in August it had its brood of *Anopheles* as it had everywhere else, and from then until late in September both *Anopheles* and *pipiens* emerged in any quantity. An interesting feature is that part of this bad breeding area runs right through the public playground and furnishes a little gentle stimulation to the children using it.

Nothing was done by this office in the matter of house to house or individual breeding place inspection.

South Orange Township.

Dr. G. Herbert Taylor is health officer and quite ready and able to do what is necessary, providing he is given the necessary financial and other assistance.

As early as April 5th, Mr. Henry Brehme called attention to the condition of the brook which comes from north of Springfield avenue, and is the line between Irvington and South Orange township. It did not become an actual breeder until early summer when *pipiens* larvæ appeared in it; but from early August, through September, it grew steadily worse, *Anopheles* larvæ being added in ever increasing numbers after the middle of August. If any remedial measures were taken they exercised no appreciable effect so far as Mr. Brehme's inspections showed.

The Rahway river infests this township as well, and the history of the breeding development here is identically the same as that of every other town. It was allowed to become choked. *Anopheles* and other mosquitoes developed almost at will after midsummer, and while there was some attempt to use oil it was only partially effective. These two streams did much to provide the mid-summer and early fall mosquito supply throughout the neighborhood.

Early in June a dirty, wet area of some 500 square feet was located on the Tuscan farm on which *pipiens* larvæ were breeding and continued to breed until after mid-September. Some of the broods were killed off by oil, others got out safely and more

time and money was wasted for no permanent result than would have been necessary to fill the place permanently.

Water supply and sewerage in the township is not in good shape and much of the local trouble is due to carelessly kept water barrels, cisterns, cesspools and similar receptacles. Inspections were made August 3d and September 16th, and these points were strikingly brought out. It will require a great deal of patience, education and tact, as well as some expenditure of money, to put conditions here in satisfactory shape.

Irvington.

Mr. Joseph K. Clickenger is health officer and pretty well posted as to the requirements of the mosquito campaign. He did what circumstances and his board permitted him to do; but Mr. Henry Brehme concludes his report on this place with the remark, "In my opinion Irvington did more than its share of mosquito breeding this season." Irvington is especially blessed with both natural and artificial conditions and, while they are entirely within possible control, it requires a united board of health and a reasonable amount of money to make conditions even fairly good.

There is a brook, about 500 feet from the Glorioux factory to Lyons avenue, which was reported as in need of cleaning as early as May 5th. *Pipiens* breeding began there in June, and while some of the broods were killed off by the use of oil, breeding was still going on in September, by which time all attempts to improve matters had been given up.

The line stream between Irvington and South Orange township is over a mile in length and was reported as dangerous, April 8th. *Pipiens* breeding began early, *Anopheles* joined during the first days of August and thereafter until the last September inspection there was no interruption in the performance.

There are a lot of small holes that could have been easily filled on the west side of the Speedway where *pipiens* bred more or less throughout the season. Some of the broods were killed off with oil, but the supervision was intermittent while the breeding was not and a great many mosquitoes escaped.

The Augusta street swamp covers an area of about 150 x 130 feet and bred both *pipiens* and *Anopheles* throughout the season in

enormous numbers. The owners made some effort to fill part of this area during the summer; but because some paper or other rubbish was blown into the nearby park, the work was stopped, the authorities preferring to endure the mosquitoes to which they were inured, rather than the offense of flying paper or other rubbish.

In addition, Irvington has an extensive back yard and factory barrel population, which was merely touched upon now and then during the season.

In natural location Irvington has much to commend it; but as a mosquito producer it is still more commendable.

Montclair.

Mr. Chester H. Wells is health officer of this town, is fully competent to deal with the mosquito problem, and has in general the necessary backing. He has not, however, had at all times the needed assistance to enable him to keep up with his work.

June 3d, mosquito breeding was found on the Montclair Park property on a swampy area which cannot be readily drained. At other times during the season larvæ were found, but mostly the place was kept oiled.

Toney's brook flows from the northern part of Montclair, south across Bloomfield avenue. July 13th, there was breeding along its edges; August 7th, large broods of *Anopheles* and *pipiens* were found and the breeding extended from north of the Montclair Water Company to Bloomfield avenue. Several broods got out here during the season.

Nishuane brook is in the southern part of Montclair, and on July 13th the edges were found in very bad condition, with a heavy brood of *pipiens* on deck.

August 7th, another inspection made along the brook showed *Anopheles* and *pipiens* back of a dozen different properties where mosquitoes had been complained of, on Llewellyn road, Orange road, Madison avenue, Draper terrace and Washington avenue. The entire brook was in very bad shape and must have given Montclair a heavy dose of both *Anopheles* and *pipiens*.

July 13th, Mr. Brehme accompanied an assistant on factory and back yard inspections, located eight breeding barrels in one factory and a number of other tubs, barrels, castings, cellars, &c.,

holding water and wrigglers and demonstrating that additional care in looking after local conditions was not undesirable.

On an early inspection in April and May, a number of breeding places for woodland spring species were located, which were in general attended to and had no effect upon the general mosquito supply of the season.

In general, Montclair is very well located and has few bad natural mosquito breeding places, but it is by no means without its problem and is in no position to sit back and criticise its neighbors without first making sure that its own back yards and streams are clean.

Millburn Township.

Dr. Wellington Campbell is health officer here, and Dr. J. Minor Maghee is inspector. Both of these gentlemen are fully impressed with the importance of the work and did what was within their power to improve matters. That they did not succeed is not their fault.

Farley's pond bred mosquitoes throughout the season, all *pipiens* so far as observed, and it is just as bad at the end of the season as at the beginning.

Glorioux's pond, north of the Millburn station of the D., L. & W. railroad, was found to be a breeder of both *Anopheles* and *pipiens*. The pond was really an artificial one, created by damming up a small stream, and the owner removed this dam, restoring the stream. This improved matters at once, confining the water to a narrow, flowing channel and leaving only five small pools on the site of the pond. These pools were oiled during the season and bred no mosquitoes, but they should be filled with a few loads of clean dirt or ashes to get rid of them permanently. The expense would be less than that of oiling for the season.

There is a pond on the east side of Brookside avenue, north of the paper mill, and here *Anopheles* breeding was found after early August around the grassy edges. There are fish in the pond, but the edges are shallow and overgrown and offer ideal conditions for these malaria carriers. It means, of course, the cleaning and deepening of the edges of the ponds so as to permit free access of the fish to the margins at all points. Nothing was done and good fall broods of *Anopheles* got out and are now in hibernation.

The Orange reservoir is on the east side of Brookside drive, about three-quarters of a mile from Millburn Centre, and this is one of the dirtiest breeders in Essex county. *Anopheles* larvæ were found there as early as June 6th, and brood after brood developed until late August. Nothing at all was done here to check breeding, and the supply of malaria carriers developed here is quite sufficient to account for some of the conditions complained of in the region. Most of the water could have been drawn off by a single ditch. The interesting feature is, of course, that it leaves us with a full supply of hibernating *Anopheles* for 1912 and a place for them to get a start on early in the year.

On the property of Mr. Stewart Hartshorne there are numerous woodland pools, breeding early spring mosquitoes only, which would not be mentioned here at all except for the fact that Mr. Hartshorne is spending thousands of dollars eliminating every possible place for mosquito development, and furnishing a refreshing contrast to the general policy of the town.

In addition Millburn has the usual house to house problem to deal with. In one tour of back yards on three streets, fourteen barrels and tubs containing wrigglers were found, and one cellar with water also, containing larvæ and pupæ.

Millburn is beautifully located and should have few mosquitoes, nevertheless it has its problem.

Verona.

The mosquito and sanitary conditions generally, of this place, are looked after by the Montclair health board and, in general, very well looked after. Mosquito inspections were made twice only, April 19th and May 2d, on both occasions for the information of the inspector, to locate woodland breeding places and general danger areas. All the points noted were looked after during the season and presumably kept in good condition. Incidentally, however, it was noted that some breeding of *pipiens* went on in the town gutters, many of which are very poorly constructed, and there is reason to believe that a cesspool population existed in some sections.

Summit.

Mr. Robert N. Hoyt is health officer and perfectly competent to look after the local problem. April 11th, Mr. Henry Brehme went over the ground with Mr. Hoyt, located the woodland pools breeding early species, most of which had been already oiled, and on June 22d, another tour of the town was made, developing nothing new.

Summit, however, has a great many catch-basins and nothing is known to me of their condition, nor was any examination made in back yards or on individual property.

The problem here was almost completely in the hands of the local authorities and I had no complaints.

Roselle.

Roselle and Roselle Park have taken no part in the mosquito work; but both of them have plenty of breeding places that need attention and that is particularly true of Roselle Park, where Mr. Henry Brehme made one inspection in late August. I had found the insects abundant enough before the end of May, and by the end of August, they were breeding in gutters, culverts and ditches throughout the town.

The inspection was made for the information of the local authorities; but so far as I am aware, no action was taken on the report that was made.

Plainfield.

July 11th, Mr. Henry Brehme accompanied the local health officer through the town to locate barrels, catch-basins, cesspools and similar breeding places. The importance of these places is never realized by the local authorities and the number of breeding places discovered is always a surprise. It developed here that while the larger and more conspicuous places were pretty well looked after, the sewer catch-basins were entirely neglected and there was no money to look after the important house to house inspection. In other words, the very species that are most obvious to the householder, are the very ones that are least looked after.

Nutley.

Dr. E. P. Whelan has charge of the work in this town and did very well throughout the season. Nutley is, on the whole, very well located naturally, and has few naturally bad breeding areas. There are some in the Bloomfield avenue section where woodland species breed in spring, but these are easily drainable, and bother little in the town itself later in the season.

An area of about 100 x 20 feet south of Centre street, in this same Bloomfield avenue section, was found breeding *pipiens* in mid-summer and that should be ditched.

The chief source of local supply is in barrels and tanks in yards and manufacturing establishments throughout the town.

July 25th, Mr. Henry Brehme went out with Dr. Whelan and located over thirty barrels, two large tanks and other breeding receptacles, and two weeks later Dr. Whelan reported that over two hundred similar receptacles had been dealt with by him. There is no mystery, therefore, as to the source of the local supply, and that supply has been seriously cut if the work was kept up with equal interest throughout the season.

Passaic.

Only two inspections were made here, in company with Health Inspector Kevitt, who accomplished wonders in his practically single-handed campaign. At the first inspection, May 8th, a number of the more obvious breeding places were pointed out by Mr. Brehme and all of these were eliminated during the summer.

July 10th, the inspection was chiefly directed toward the mills and factories and an unexpectedly large wriggler population was found. In some mills and yards from twenty to twenty-five tubs and barrels, all with wrigglers were found, and the aggregate number of larvæ was terrific. This work was carried further and cared for a large mosquito population that would otherwise have aided in making life miserable.

Unfortunately Mr. Kevitt could get no help in caring for the breeding in catch-basins, so that this source of supply continued practically unchecked throughout the season.

Hackensack.

The authorities in this city manifested a great deal of interest in the mosquito problem, and I lectured during the winter of 1910–'11 on the general subject of mosquito control. The inspector, Mr. Fritz M. Arnolt, was enthusiastic in the work, and I sent Mr. Herman H. Brehme over the city and its surroundings with him, to point out the danger areas.

June 28th, Mr. Henry Brehme went over the same territory with Mr. Arnolt, and found everything oiled and no breeding going on. On the other hand, the back yards and factories proved veritable mosquito mills, fifty barrels in one factory yard being found swarming with larvæ and pupæ, while smaller numbers were everywhere throughout the city. It seemed to be at all points the most typical case of breeding your own supply in your own premises, with a liberal supply over for general stock and open street.

The slaughter in this city alone, of wrigglers and pupæ, was beyond computation, and much of the relief is permanent.

Hudson County.

It has been several times mentioned that the work in Hudson county is under the supervision of Mr. William Delaney, an appointee of the county board of health. At my request Mr. Delaney submits the following report of his operations in the county, exclusive of the work done on the Kearny meadows, and in the other municipalities and localities that are specifically treated.

Mr. Delaney deserves unlimited credit for what he has succeeded in accomplishing in Hudson county with very little backing from the actual governing bodies. He has secured his help in almost every instance from those directly interested as owners in the territory to be benefited. He writes:

"I have the honor to submit the following report of mosquito work in Hudson county, under the supervision of the county board of health, during the past summer, exclusive of work on the Kearny meadows, a record of which you have.

"The work here, as is the case generally throughout the State, is being prosecuted under very adverse circumstances, owing to a

lack of interest on the part of municipal authorities. However, the co-operation of private individuals and corporations has far exceeded any assistance heretofore rendered in scope at least, if not in actual expense, and were it not for such co-operation with the efforts of the county board of health, I should not be able to report very much progress."

A careful inspection of the drained area, as outlined in my last report, was made during July, 1910, and the necessity of about fifteen thousand (15,000) feet of ditches was found. Through your office those ditches were installed during March and April, 1911, completing about fifty (50) miles in the county to the above date, after which I had the entire drained area thoroughly inspected and ditches cleaned where necessary, and it may interest you to know that I found almost all the ditches in perfect shape and efficiently working, even those which were made in 1907. That part of the work completed, I devoted my time to breeding places on private and corporation property, and during the season I have had the pleasure of seeing very many breeding places wiped out of existence.

Of course, I cannot give a detailed account of the assistance received from all interested parties. I desire, however, to give credit where due, and mention a few of those to whom I applied and from whom I received ready and very material assistance.

In July, I found considerable breeding of salt marsh mosquitoes in what is known as the Secaucus meadows, on a part of the meadows east of Penhorn creek, north of the Greenwood Lake branch of the Erie railroad, and south of the Delaware, Lackawanna and Western railroad, owing to the fact that the ditches there did not thoroughly drain the territory. Being without the necessary money to remedy the trouble, I applied to Mr. A. J. Næfie, principal assistant engineer of the D., L. & W., the trouble being adjacent to the Boonton branch of that road. Mr. Næfie very kindly consented to inspect the trouble, and on the 12th of July I had Mr. Næfie's permission to have the necessary work done and charged to the D., L. & W. railroad. I had Mr. Jesse P. Manahan, of Red Bank, do the work, the cost which was two hundred dollars ($200), was paid by the D., L. & W. railroad. In connection with this matter, I desire to say that this company was not in any way obligated to do this work, the trouble was not on the railroad property; but like all other corpora-

tions with which I have dealt on matters pertaining to the work, they were ready and willing to do more than their share.

The Central Railroad of New Jersey have used oil on all breeding places on their property which have not been filled in.

The Hudson County Park Commission have taken care of all their property by the use of oil.

The Jersey City Shade Tree Commission, who have charge of city parks here, very willingly complied with my suggestion and have done about all that was done in Jersey City to prevent the breeding of *pipiens*, the city board of health having done absolutely nothing.

However, I believe the people generally are becoming more impressed with the idea that the mosquito pest can be abolished, and that the time is not far distant when this work will receive the support of municipal governing bodies and the encouragement of the people generally. I draw these conclusions from the fact that when people who are in a position to help are convinced that the thing can be done, they are willing to render assistance.

The Public Service Corporation, owners of considerable real estate in the county, are among those who deserve special mention, from the fact that they have readily assisted since the work was under the supervision of the county board of health. During the past summer they have continually cared for breeding places on their property, by the use of oil. In July last I arranged with Mr. Osgood, of the Public Service Corporation, the preliminaries of a contract which is now being fulfilled, by which they are having filled in all breeding places on the real estate holdings in and surrounding Jersey City, at an expense of six hundred dollars ($600).

The county park commissioners, whose meadow property extends from the West Side Park, Jersey City, to the Hackensack river, in area twenty-five hundred by fourteen hundred feet (2,500′ x 1,400′), and upon which some *sollicitans* and *cantator* were bred during the past season, are now arranging to *thoroughly* drain this area, which will eliminate that as a breeding ground.

On county property at Snake Hill I found considerable breeding during the past summer, and owing to the fact that the new Pennsylvania electric railroad separated this property from the Hackensack river, I found this a rather difficult and expensive proposition to drain. However, after several conferences with

the county freeholders and Mr. C. S. Krick, superintendent, and Mr. Harris, division engineer of the Pennsylvania railroad, I have undertaken a system of drainage which necessitates cutting through two embankments, one, two hundred feet (200′) wide and the other, two hundred and fifty feet (250′) wide, and varying from three (3′) to eleven (11′) feet deep, in order to draw stagnant water to railroad culverts and through them into the river. This work has been in course of progress since October 12th and will be completed about November 15th, costing in the neighborhood of seven hundred dollars ($700), the Pennsylvania Railroad Company defraying one-half cost and the county board of freeholders one-half.

Including the work done in the township of Kearny, the expense of which was defrayed by your office, I conclude that about forty-two hundred dollars ($4,200) worth of ditching and filling in was done in this county under my supervision since March last. This amount, of course, does not include money expended for oil and labor in treating breeding places in the county.

During the season just closed the mosquito pest was quite troublesome in Hudson county owing to the fact that, as above mentioned, municipal authorities entirely neglected such breeding places as sewer catch-basins, resulting in an abundance of *pipiens*. I am satisfied, however, that this county was never so free of the salt marsh mosquito as during the past year, which I think the reports of your inspectors will verify.

Secaucus.

Conditions on the Secaucus meadow have been good throughout the season in a general sort of a way. Several inspections have been made from time to time, the usual monthly inspection for the benefit of the Mosquito League, and several others at the request of Mr. Delaney.

At the time that the meadow in this section was originally drained it was a small triangular piece of salt marsh cut off by an embankment of the Pennsylvania railroad, taking in a portion of the Isolation Hospital, and leaving a small swampy area without outlet of any kind except over a solid right of way. This area was carefully examined by Prof. Smith and myself, and Prof. Smith decided that, left as it was, it would change its char-

acter from salt marsh to a fresh water cat-tail area in the course of a year or two and become harmless as a mosquito breeder. A conclusion with which I agreed.

During the summer of 1911 Mr. Delaney found a very large number of mosquitoes in this area, many of them salt marsh species, but the adults only, and no evidence that the insects actually bred there. The territory while not really a mosquito breeder at this time unquestionably does harbor mosquitoes, and Mr. Delaney succeeded in interesting the railroad in its removal. There is a culvert through the embankment of the Pennsylvania railroad some distance up the marsh, which leads into Penhorn creek, but to reach this culvert it will be necessary to dig through a ridge of highland and to make a permanent trench through solid ground, and afterward to carry a wooden trunk through a mass of semi-liquid mud in order to hold open a drain that will carry off the water through the culvert into Penhorn creek. It can be done, however, at a cost of about six hundred dollars, and it will undoubtedly facilitate the drying off of this triangle.

The rest of the Secaucus territory was State ditching work, which maintained itself during the season with practically no attention, and no adverse conditions developed here. It was a case of work properly done in the first place, which simply needed looking after to prevent interference.

Vallsburgh.

This is really to be treated as a section of Newark and was dealt with as such throughout the season by Mr. Dobbins. The brooks and swampy areas here were found in bad condition early in the season, and all the brooks were improved by cleaning or improving in flow. A great deal of oil was used and was necessary because brood after brood developed at one point or another. At the end of the season matters had improved somewhat and the area is in better condition than it was a year ago. It is one of those places that Mr. Dobbins can himself tell about.

Figure 1.

Street scenes in Newark, showing catch basins ready to be oiled.

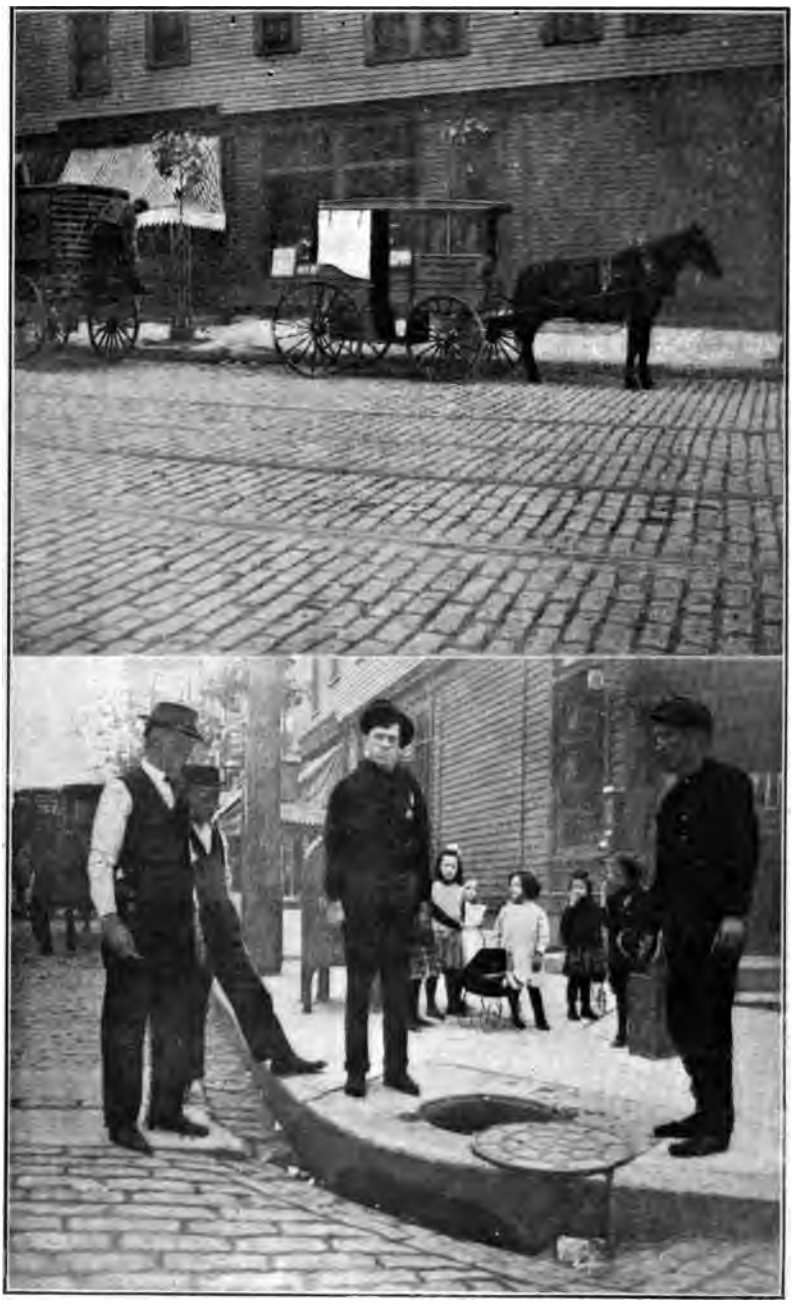


Figure 2.

Street scenes in Newark: getting ready to oil catch basins.

Waverly.

This also is really a section of Newark and was under the general charge of Mr. Dobbins's men. There were two swampy areas of considerable extent on the west side of Frelinghuysen avenue and on the south side of Evergreen avenue, and these were dirty *pipiens* breeders as early as May. They were oiled again and again and very few insects got out, but no improvement was made in the character of the place and it is as virulent a breeder now at the end of the season as it was at the beginning. The places must be filled to be cured.

There are two brooks east of Frelinghuysen avenue, one of them south of Evergreen avenue, the other north of McClellan street. They were both breeding *pipiens* in May and throughout the season, and both were oiled again and again, millions of larvæ being killed off. Nothing else was done to the first mentioned of the two brooks and no doubt a goodly number of mosquitoes escaped the oil. The other brook was cleaned for a distance of about one hundred feet, given a better flow and no doubt kept under better control, fewer specimens issuing during the season.

Newark.

This record, as indicated, is practically as handed in by Mr. Dobbins. There have been some necessary changes in the reference to the salt marsh work to make it accord in general with the account given elsewhere of the work on this territory, and it has been deemed well to bring the general account of the work in the city in line with the accounts given in the other places.

Mr. Dobbins writes: While we have been fighting mosquitoes here for the past seven years, this is really the first year that the work has been done along systematic lines, and the amount of work which had to be done at the start was so enormous and so unexpected that we could not prevent great numbers of mosquitoes from reaching the winged stage.

On March 1st we started work on the salt meadows. Many of the ditches had not been systematically nor thoroughly cleaned since they were first cut, and, as a result, whereas they were originally about twenty-four inches deep, the sedimentation of years

had filled them in some instances so completely that it was found desirable to recut rather than to clean. With a force of fourteen men we worked on the meadows until May 10th and then took up the city fight against *Culex pipiens*. When the work was stopped on the meadows much still remained to be done, and it will take another year before we have the area as thoroughly cleaned as is desirable. We are now working on the meadows this fall, continuing the work where it was left off in spring, and will continue until freezing. All pools will be connected up to the ditches directly, so as to avoid breeding conditions caused by continued east winds, rains, full moons and high tides, and I feel certain that so far as Newark is concerned, we will breed very few marsh mosquitoes next summer, provided we can complete what work we have to do before breeding time next spring.

I took up the work with the fresh water mosquitoes early, so as to be in a position to thoroughly study this phase of the work and not to be caught unprepared. I started with two wagons, oiling the catch-basins even before there was any indication of breeding in them to make sure that no mosquitoes came from them during the summer. I so arranged this work that each basin received a coat of oil once in fifteen days, and, profiting by past mistakes, the oil was sprayed in the basin only after the top lid had been removed, so that the man doing the oiling had a clear view of the entire interior of the basin and could see that every part of the water was covered. I consider this part of the work a thorough success, and am sure no mosquitoes came from the sewer basins during the past summer.

We also kept all standing rain water collections under close observation and covered them with oil whenever necessary, and this work was done so persistently that I am sure no breeding occurred in these places. The great hordes of larvæ that we killed off in these pools during the past summer cannot be estimated in numbers.

The several brooks which run through the city were watched closely, and so far as that part of them that traverses the Newark city limits is concerned, very little breeding took place in them and very few adults matured. We were very liberal with our applications of oil and saw these brooks at frequent intervals.

Now, to those not thoroughly familiar with the work, it would seem that this would be sufficient to warrant a great reduction in

mosquitoes, but such is not the case. When, after all the work we had done, the fresh water mosquitoes became prevalent in large numbers, but not by any means as prevalent as in former years, there could be but one conclusion, and that was the necessity for a house to house inspection of the entire city. This was a large proposition for my limited force of three men, myself included; but to satisfy my curiosity I started this sort of an investigation, and it revealed a condition beyond all expectation. For instance, in the tannery of Henry Lang & Co. I found twenty odd vats in an abandoned beam house. The vats had not been used for two years, and each vat contained a large quantity of water swarming with wrigglers. In the storage yard of the Hedden Construction Company we found forty-four barrels containing water in which mosquitoes were breeding in enormous quantities.

We have found to date—and the work has covered less than half the city—more than eight hundred barrels breeding mosquitoes, forty-six cisterns used for no purpose except to breed mosquitoes, since city water has been installed, about seventy-five abandoned wells, and every tannery building breeds mosquitoes in all the vats not in use, and which are kept full of water to keep them "tight." Of course, this accounts for the swarms of house mosquitoes that are so generally distributed throughout the city.

I have succeeded in having several bad pools filled in and have pictures of such places showing the conditions before and after filling. The Lehigh Valley Railroad Company on my recommendation has filled in several places at considerable expense, one in particular being the worst place I had in the city, about two hundred feet long and twenty feet wide, in the Hamburg Place freight yard.

During the winter months I expect to have several bad places filled in with garbage and then to have a layer of clean earth over it before spring.

We have learned a great deal more of the problem this year, and it has brought clearly to my mind the importance of a house to house inspection.

It would surprise you to see the number of barrels found in the yards of German people, who have a little garden and use barrels to catch the rain water to put on the flowers and truck in dry seasons. The Italians are great drinkers of home-made wine. In summer they put the barrels from which the wine has been con-

sumed into the yard, partially fill them with water to keep them tight until the grapes are ripe and the wine-making time arrives.

Just think, in the yard of one of the city's wealthiest residents on Mt. Prospect avenue, we found thirteen sewer catch-basins all hatching out one brood after another of mosquitoes! In the blacksmith shop of J. N. Quimby & Co. we found them breeding in the tubs alongside the unused forges, while in a factory making hat machinery we found them breeding in the machines. There is a box on each of these machines to "douce" the hat form in. Several of these new machines were on the floor and all breeding *pipiens*.

I hope to start the house to house inspection early next year by dividing the city into districts and placing an inspector in each district. I have carefully noted conditions this year and have listed every place where breeding has been found, and next summer the inspector will see these places at stated intervals.

We do not urge upon the people to get rid of a barrel when we find it, for they may sell, and then we would probably have to hunt for it all over again. We simply tell them how to keep it and then go back from time to time and watch it.

Lyons Farms.

The authorities of this place do nothing; both Mr. Dobbins, of Newark, and Mr. Richards, of Elizabeth, keep it under observation, and Mr. Henry Brehme made several inspections during the season. There are several swampy areas of considerable extent in which *sylvestris* and woodland species breed from time to time, and these should be drained as they easily can be.

The worst of these areas, because it breeds both *Anopheles* and *pipiens* as well, is located south of the Irvington branch of the Lehigh Valley railroad and the Glorioux plant. This was oiled once during the season by the Elizabeth force. It can be drained, without much cost or trouble, into the brook, and until that is done it will be a source of danger to North Elizabeth as well as its own immediate surroundings.

A more temporary danger area of about 150 x 100 feet is on the north side of the Lehigh Valley railroad, opposite the West Elizabeth station. This fills in long rainy spells or in heavy downpours, and produced only one huge brood of *pipiens* which Mr. Richards succeeded in killing off before it got on the wing.

In addition to these rather extensive areas which make Lyons Farms a source of danger to its immediate surroundings, it has a supply of cesspools and other sewage conditions which give it a local supply of considerable extent, against which nothing whatever was done by local forces.

Elizabeth.

The following report was furnished by Mr. Louis J. Richards, the health officer of the city of Elizabeth, at my request.

INSPECTIONS.

These were started on January 6th, and two inspectors and the writer made frequent inspection from that date until the first of October in watching conditions, discovering breeding places and notifying owners of pools. A house to house inspection was made in June of all the section north of the Central railroad from the Elizabeth river to Madison avenue, as in this and the two previous years *pipiens* were more numerous in this section than in any other part of the city. There are fewer rain water cisterns, outhouses or low lots incapable of drainage in this section, and it should be the freest from house mosquitoes. With the exception of a few manure barrels, barrels of water for watering gardens, and a few smaller receptacles, very little breeding was found, and the conclusion was reached that the number of mosquitoes was entirely out of proportion to the few breeding places discovered, and must have been due to a flight from a considerable distance, in some cases well over a mile. While this is being written Mr. Henry Brehme, of your office, is making a thorough inspection of the adjoining districts in Union county bordering on this and on the northwestern section of this city, with a view of determining and locating sources of probable breeding, so that interest may be aroused and action taken before the spring breeding season begins in 1912.

In addition from April to the 1st of October, both Mr. Herman H. Brehme made frequent inspections of the salt meadow, and Mr. Henry Brehme of the upland area, reporting any mosquito breeding found, which was always promptly attended to and the spots drained or oiled.

CELLAR FUMIGATIONS.

These were started on March 18th, and from that date until the end of April, 54 cellars were fumigated to destroy hibernating mosquitoes. The mode employed was with Mim's Culicide, at the flat rate of $1.50 per cellar, irrespective of size, as recommended at the February meeting of the North Jersey Mosquito Extermination League. As cellars varied from 8,000 to 30,000 cubic feet in contents, and as the charge, if labor is included, did not cover the expense, I should suggest that, unless the work is done gratuitously, the charge be not less than 15c. per 1,000 cubic feet, which would just about cover all costs when supplies are obtained at the wholesale rates. As the State law only prohibits the harboring of larvæ and not adult mosquitoes, it is doubtful if the owner or occupant of any premises could be compelled to get rid of hibernating mosquitoes; but public sentiment demands that nothing be left undone to eliminate or lessen the pest, consequently it will be for some years to come a portion of a health department's work to fumigate cellars. This being so, it is proposed to recommend an early response to the notification, so that the work can be finished so far as possible before the end of March, when attention can better be turned to outdoor work.

The following is a table of costs, with the exception that labor is only charged for seven days' time in which 21 fumigations were done. The remainder was done by inspectors of the board, as the man who was hired for this purpose became ill and a suitable substitute could not be found.

STATEMENT—CELLAR FUMIGATIONS FOR MOSQUITOES.

Labor—	7 days, at $2.00	$14 00	
	Car fare	1 40	
			$15 40
Culicide—	25 lbs. Camphor, at 48c	$12 00	
	25 " Carbolic, " 13c	7 28	
	20 " Camphor, " 50c	10 00	
	10 " " " 50c	5 00	
	10 " " " 50c	5 00	
	10 " Carbolic, " 15c	1 50	
			40 78

Alcohol—			3 15
Apparatus—	Alcohol lamps, &c	$8 80	
	Generators, 12 at 35c	4 20	
	Tins, &c	72	
			13 72
	Total expenses		$73 05
Receipts—	Fumigations, 54 at $1.50		81 00
	Balance to City Treasurer		$7 95

PREPARATORY WORK.

This was started on January 9th, and up to February 3d, 36 days' time were used in cutting brush several thousand feet along an old water course leading from Old Port avenue, near Division street, to the outlet of the Fairmount avenue sewer, and thence to Woodruff's creek on the salt marsh. Along Henry street, north of Olive street, numerous pools were then cleared of heavy brush which could be done only when the ground was frozen, and which would permit the oil to reach all parts of the surface. This section of the city comprising the upland north of the Central railroad and east of Henry street, is often called "The Bush," and certainly it is well named, for a more compact second growth of oak and other trees entwined with briars and vines would be hard to find. Some of the pools occurring here can be drained into the outlet ditch, but others had to be cleared for treatment.

In addition, the stock of tools was looked over and needed new supplies obtained.

Great ditch, the outlet for a large section of our salt marsh, was cleared of stones on March 23d, which were placed there in the winter by boys.

DRAINAGE—INLAND.

This was started March 16th, and continued to the end of May, with some interruptions when the men (from two to eight in number) engaged in this work were shifted to the meadows to oil or to help out the regular gang upon particularly favorable days when the tide was low or conditions required their services. The total amount of labor used for this work was 125 days.

The ditch leading from Old Port avenue, near Division street, to Woodruff's creek, which had already been cleared of brush early in the season, was cleaned out, removing all pockets formed by obstructions in the old ditch and draining a large area of swampy brush land, and also a pond of several acres in extent which apparently had a few larvæ along the brushy and overgrown ditches, but where thousands were found as the water receded and they could be observed as they floated down the ditch or collected in the small muddy pools left. This was an admirable example of a pond overgrown with a mass of water brush and grass which concealed most of the larvæ present. It was impossible to oil even the ditches of this pond before drainage, which was fortunately completed by the middle of April in time to cut off the first brood.

The following old drainage ditches were also cleaned:

Along Fay avenue, on the west side of the Pennsylvania railroad, from Bayway to the city line.

Along New York avenue, on the east side of the Pennsylvania railroad, from Bayway to the city line.

West of Grove street, near Murray, in Fay's woods.

On Westfield avenue, east of Grove street. (This property has since been filled in.)

On West Grand street, east of Grove street.

On the west side of the Pennsylvania railroad from North avenue to the Waverly line.

On Sheridan avenue, from Wilder street to the Waverly line.

In addition, the Elizabeth river was cleaned from Parker road to Bridge street.

On June 20th the first flight of *pipiens* was noticed, and complaints were received from the north and northwestern parts of the city. Since then, up to the first of September, notwithstanding our best efforts, *pipiens* have been abundant and a pest in these sections of the city. After the first part of September they gradually disappeared.

DRAINAGE—SALT MARSH.

The work on the meadows began on April 4th and continued until May 23d, with a force of men varied from 15 to 20. After this date two men were kept on the meadow until the middle of June, by which time our funds were exhausted and all salt meadow

work with the exception of some oiling (described below) was stopped. Our first drainage on the meadows was done in 1902 and continued during 1903, 1905, 1906 and 1907, by which time the total meadow had been drained. In the fall and early winter of 1908 Great ditch was widened and deepened, and Woodruff's creek and other large drainage outlets were cleaned. In 1909 and 1910 the greater part of the small drainage ditches had been gone over, but this was the first year that all the ditches on the west and south meadows were all cleaned out in one season.

The first brood of salt marsh mosquitoes noticed by me on our meadows was hatched around Bay pond on May 7th. The cleaning of the ditches had proceeded almost to this point at that time, consequently the flight was small and very few reached the city. From the 30th of May to the 13th of June it rained almost continuously, as almost six inches of rain fell. On June 9th the salt marsh species were quite abundant in the city, but after the rainfall, ending on the 13th, ceased, the salt marsh mosquito disappeared, and from that time on we have had no trouble from them this season, except during the first ten days of September a small brood was noticed.

OILING.

That portion of our salt marsh adjacent to the south and southeast edge of Great Island is low and a considerable distance from the main outlet ditches, and as a result the surface water does not run off after a rain in time to prevent some hatching. To remedy this your office kindly undertook to provide the means for labor and oiling this territory. The first oiling done here was on May 9th. From this date up to the first of October an expense of $25 for labor (consisting of 16 days' men, at $1.50, and one day horse hire, at $1) and $51.80 for 20 barrels of oil containing 1,036 gallons at 5c., or a total expense of $86.80, was incurred. It was necessary to treat the meadow four times during this period.

The first work of oiling pools was done on May 11th and continued up to November 14th. The catch-basins were oiled once in May, twice in June, once in July and once in August. In the intervals between the oilings samples were taken from numerous catch-basins to find out whether any larvæ were present, and the oiling was done as soon as they appeared. Our own horse and

wagon were used, and two of our inspectors detailed to this oiling, so no additional expense was incurred for labor. The number of barrels of oil used was 68.

AMOUNT EXPENDED.

The total amount of funds available and expenses incurred now follow:

FUNDS.

Appropriations—City Council		$500 00
State (contract with W. F. Reider)		300 00
Contributions—Private citizens		661 50
Balance—Cellar fumigations		7 95
Abating mosquito nuisance on private property		36 00
From Health Account for oil, tools, &c		293 36
		$1,798 81

EXPENSES.

Oil—	68 bbls of 3,572 gals., at 5c	$178 60	
	Cr., 4 Formalin bbls	4 00	
			$174 60
Boots—	23 pr. Storm King, at $4.16	$95 68	
	4 pr., at $4.75	19 00	
			114 68
Tools—	20 Hooks, at 55c		11 00
Pipe—			5 90
Labor—	Cutting brush and cleaning inland ditches		250 00
	Cleaning out ditches on meadow		942 63
	Contract (State with W. F. Reider)		300 00
			$1,798 81

SUMMARY AND CONCLUSIONS.

Much preparatory work can be done in the winter in cleaning out brushy pools and water courses which can easily be done when they are frozen over and free from the leafy growths of summer, in locating possible sources of breeding, and in cellar fumigations. This latter mode of getting at mosquitoes is expensive, and although to our present knowledge it seems well worth the outlay, it is really the wrong method to pursue in eliminating them, as the most efficacious manner is to remove their breeding places or to destroy them in the larval stage.

We have been unable to find a satisfactory substitute to elimte breeding in catch-basins besides oiling, which I think need begin before the middle of May nor continue after the middle September. These places are well below the surface of the und, and the hatching retarded on this account. There is a siderable number of old drainage outlets which were formerly oks and are year by year becoming more constricted on account building operations and the construction of sewers whereby the face water is carried away by these means. However, it is essary to go over these every year to see that they are clear and form their functions as well as not being breeders in themves. There are a few rain water cisterns left in some sections ich have to be watched. With the extension of the water mains se are being removed.

The salt marsh ditches should be gone over carefully and thorghly every year, which should be started in February or March the latest, and completed before the end of April. Each year amount necessary for this will be less, as most of the ditches l keep themselves in good working order, but there will always a certain number to get obstructed either by falling in of the ks by obstructions placed by salt hay cutters or others, and the ural stoppage due to sluggish flow and the accumulation of vy grass from the banks which often falls in when the adjoining adow is burned over.

In conclusion, would say that mosquito extermination has be- e a regular branch of the work of our health department, and t few recognize how great an amount of time is devoted to this . how much territory is covered and work done with the amount ended. While the house mosquito has been a pest in some ts of the city during the past summer, yet we know that it ld have been infinitely greater if we had not carried on our paign. We also know that one community may suffer from the c of interest in another. So far as salt marsh mosquitoes go y have ceased to become a pest. The work done by the inctors from our office both in the inland and on the marsh is cing a great stride toward solving the mosquito problem, algh the force is entirely inadequate to completely cover the itory which is necessary. It is to be hoped that more men

can be detailed to this work so that all hands may be ready for an active start before next spring.

I thank you for your many helpful suggestions and financial support, and assure you always of our hearty co-operation.

SUPPLEMENT TO THE REPORT REFERRED TO BY MR. RICHARDS.

The following mosquito breeding places were located by Mr. Henry H. Brehme, in Lyons Farms, October 30th, 1911:

The first section is located east of the main line trolley, south of the Lehigh Valley railroad. This place is a *pipiens* and *Anopheles* breeder, and should be filled about a foot or fifteen inches, which will eliminate it forever. Oiling will do some good.

The second section is a small swampy place which is located near Miller's coal yard. This is a *pipiens* and *Anopheles* breeding place and should be filled. Oil could be used as a palliative.

The third section is the brook which runs down on the north side of the Lehigh Valley railroad, west of Elizabeth avenue. The only thing that can be done here is to keep it clean, so the water has a good flow.

The fourth section is a dirty swamp, south of the Irvington branch of the Lehigh Valley railroad and the Glorioux plant. This place is an *Anopheles, pipiens* and *sylvestris* breeder. The only thing that can be done is to deepen the brook and drain into the same.

The fifth section is a large pool which is located on the west side of the West Elizabeth station of the Lehigh Valley railroad. There was *pipiens* breeding found here last season. The only thing that can be done here is to oil, as this water all comes down a brook and forms a large pool.

The sixth section is a swampy place which is located on the west side of Prospect street, north of Conant street. This is the place where the lady would not let your men oil last summer. These premises should be filled in.

The seventh section is a large *pipiens* breeding pool which is located on the east side of Prospect street, north of the Schuler property. This place should be filled and oil will do some temporary good. I saw very many old cans and pails dumped along Prospect street. These will all make breeding places for *pipiens*.

he gutters in Lyons Farms are in very bad condition and should
: kept clean during the summer.

The eighth section is a large pool which is located on the east
de of the Lehigh Valley railroad just south of the West Eliza-
:th station. The only thing that can be done here is to oil, as it
.nnot be drained and will take a long time to fill it.

The following breeding places were located in Union township
ctober 31st, 1911:

The first section is a *pipiens* breeding place which is located
ı the west side of the Lehigh Valley railroad about four hun-
:ed feet south of Long avenue. This place should be filled or
ıltivated out of existence. It is on the property of the Elizabeth
'ursery Company.

The second section is a *pipiens* breeding place which is located
ı the east side of the Lehigh Valley railroad just north of Salem
ıad. This place is also on the property of the Elizabeth Nursery
ompany, and the best thing to do here is to fill it in.

The third section is a very dirty swamp which will breed
ipiens, Anopheles and the woodland species, and is located from
ıe side of Long avenue almost to the Lehigh Valley railroad,
ong the brook which comes from the Irvington branch of the
ehigh Valley railroad and flows south across Salem road. The
ıly thing that can be done here is to deepen the brook and drain
.to it. No doubt Elizabeth got a good many mosquitoes from
is swamp last summer.

The fourth section is a small swampy place which will breed
piens and *Anopheles,* and is located on the west side of Baker
reet between Long and Silver avenues. This place can be
ained and oil will do some good until permanent work can be
mpleted.

The fifth section is a small swampy place where *pipiens* will
eed and is located on the north side of Boston avenue about two
ndred feet west of Baker street. This place can and should be
ained.

The sixth section is a small ditch which is located on the east
le of the Lehigh Valley railroad just south of Salem road. This
tch will breed *pipiens,* and the best thing to do here is to fill it.
ling will do some good.

The seventh section is a swamp which is located about one
ousand feet east of the Lehigh Valley railroad and about one

thousand five hundred feet south of Salem road. This swamp will breed *pipiens* and this section can be drained into the stream on the south of it.

The eighth section is a swamp which is located on the west side of the Lehigh Valley railroad. This swamp will be a bad *pipiens* and *Anopheles* breeding place. The largest part of this area can be drained, but some oiling will have to be done here for a time at least.

The ninth section is a swampy place which is on the west side of the Lehigh Valley railroad about six hundred feet north of Morris avenue in Townley. This section looks to me to be a bad *pipiens* and *Anopheles* breeding place. A few ditches cut here to the brook on the north of it will drain this place. The gutters along North avenue, just east of the ice ponds, are in very bad condition, and I saw much water in them to-day, which no doubt was the case last June and August when we had so much rain. These gutters will make good *pipiens* and *Anopheles* breeding places.

I also wish to state that where there is any dumping of ground or ashes done by a contractor, he should be compelled to level it off so no holes will exist.

It is my opinion that Elizabeth must have gotten millions of mosquitoes from these sections of Union county.

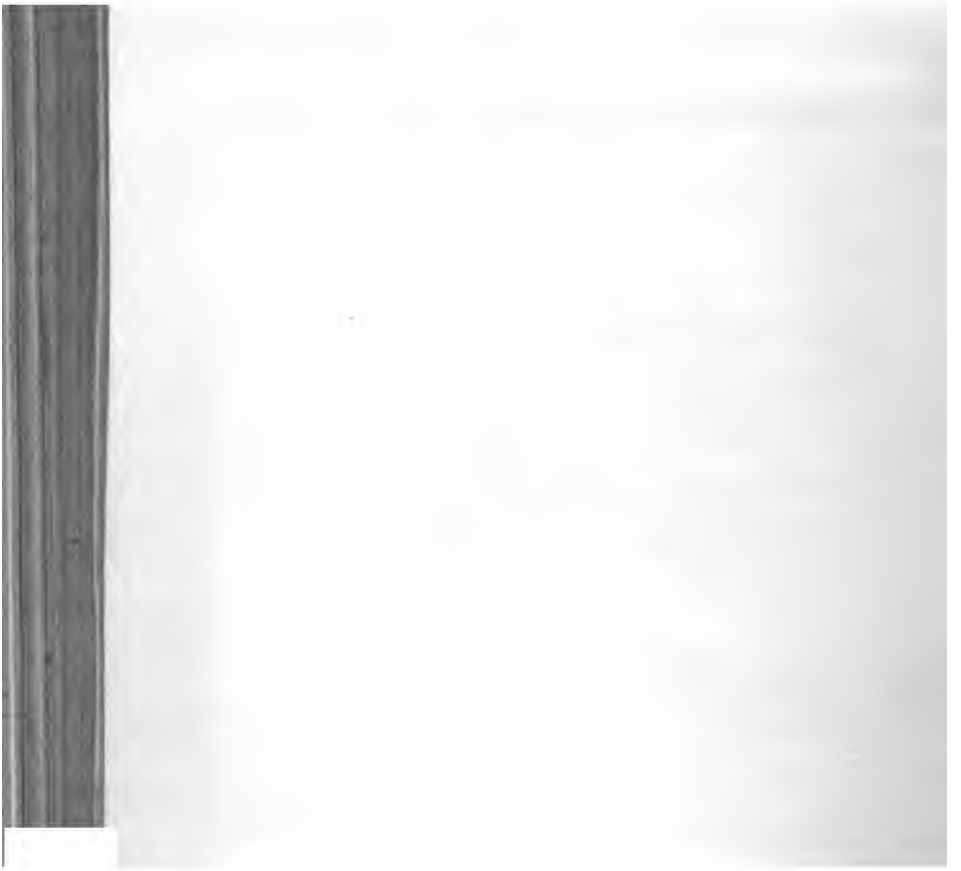
SALT MARSH PROBLEMS.

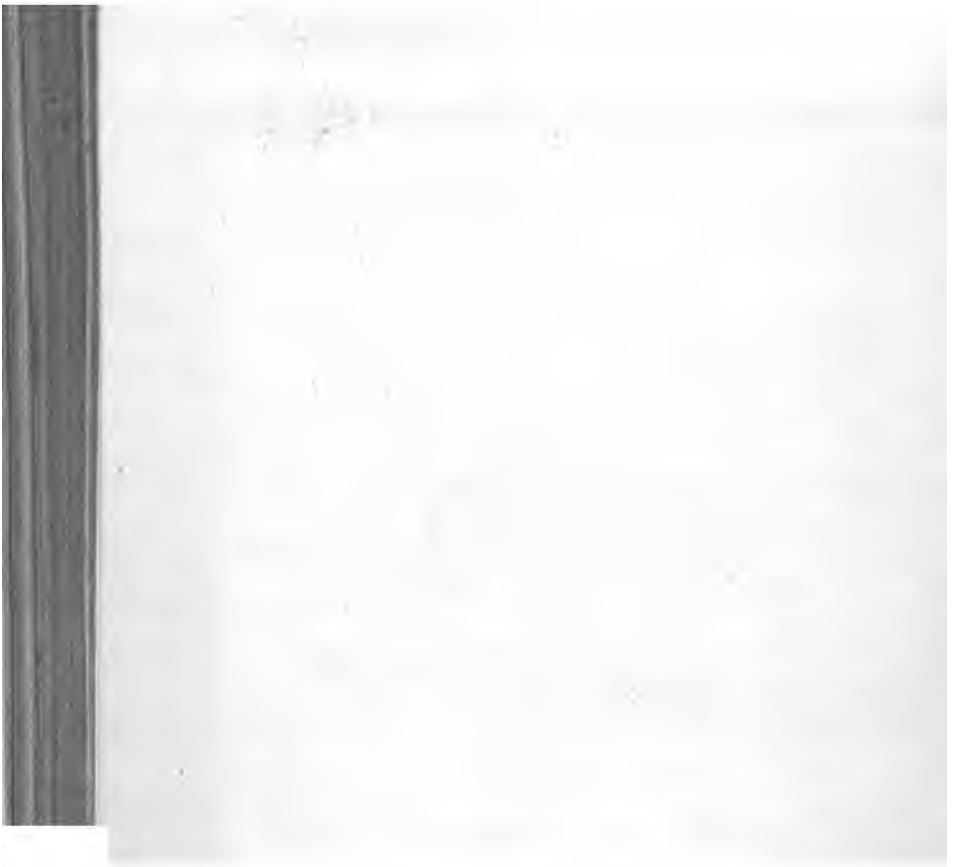
Kearny Township.

For some time I suspected that north of the line of the Pennsylvania railroad, between the Hackensack and the Passaic rivers, there was some territory on which salt marsh mosquitoes bred, that found their way into North Newark and the communities directly west. It proved impossible, however, to demonstrate this. There was always Point-No-Point with an enormous number of breeding places, and mosquitoes in any quantity present, and always when we investigated the territory north of the railroad either no larvæ at all among the cat-tails, or such a scant scattering, that it did not seem possible that they could be charged with producing the swarms found in the various communities.

The building of the new line of the Pennsylvania Railroad Company parallel with the old line and the changing of many of the

Figure 3.





roadways across the meadow during the latter part of the season of 1910, led to a re-examination of the whole territory in the very early spring of 1911, and developed a condition of affairs that was utterly unexpected and illuminating.

It was found that very early in the season, long before we had under ordinary circumstances anticipated finding larvæ on this territory, full broods of *cantator* developed here, and that the entire area between the Pennsylvania railroad, the new line of the electric road and between the new line and the turnpike, was really a virulent breeding territory, to a very restricted extent. For years advertising signs had been put up on this meadow. These lasted for a season, or sometimes only part of a season, were blown down and then partly torn out, leaving holes. Hundreds of holes were over the meadow, and it turned out that every one of those holes was full of wrigglers. When examinations were made in April, a perfectly terrific brood of salt marsh wrigglers was found over all this territory, and almost all in these small holes.

The problem here was a distinctly unfortunate one and a difficult one to deal with. The railroad embankment, from the Hackensack to the Passaic, is solid, or with only a single break near the city of Newark. There is no way of getting the water from north of the railroad dam to the Passaic river, and the Passaic at high tide is almost at a level with the meadow itself. The run along the length of the railroad dam from the Hackensack to the Passaic was altogether too great to make it possible to contemplate a cutting through from side to side, and we were left, in addition, with a pocket between the steam road and the electric road of the Pennsylvania railroad.

After consultation with Mr. Brehme and Mr. Manahan, we decided that a large measure of relief could be obtained by opening up some of the old ditches that were on the meadow, and forming long, deep and rather wide channels which could be stocked with killies. They were really lengthy ponds that were being created and ditches to drain into them. This would centralize the water-supply and would get it out of the holes, and, at the same time, give us material to fill a large percentage of the holes so as to do away with the breeding places.

Three separate localities were dealt with in that way, involving an expenditure respectively of $900, $600 and $600, a total of $2,100. This work was done immediately and several thousand feet

of ditching was put in—narrow and wide—covering an area of several hundred acres. Later in the season practically no breeding took place on this territory, and that has been the experience in past years. This territory is a very early spring breeder only, but it does supply that early flight of mosquitoes that gets into the Oranges, into Nutley, Belleville and through that territory during the early days of May.

Attention having been drawn to this territory, I kept both Messrs. Henry and Herman Brehme on that section of the meadow and at the edge of the marsh bordering Kearny until another distinctly unpleasant and unsatisfactory condition of affairs was developed, for which, up to the present time, no cure has been found.

Kearny sewers into the Passaic river through a narrow stream rather more than a mile in length, known as Franck's creek. This enters the meadow at Schuyler avenue, runs south through Kearny meadow, in a general sort of a way parallel with the Passaic river at some distance inland, and over it, crossing the lines of the Erie, the Greenwood Lake, the Delaware, Lackawanna and Western railroad, the Newark turnpike and the Pennsylvania railroad before it empties finally into the Passaic river. It crosses the turnpike and the railroads through culverts that are no larger than absolutely necessary to carry the water, and the stream always runs bank full.

At one time Franck's creek undoubtedly ran through the meadow itself, and had a bottom that was lower than the present level of the meadow. In the course of time the sediment from the sewage filled up the bottom until the bottom was level with the top and the edge of the surrounding banks. Then under pretense of cleaning out the bottom of the stream, a foot or two was taken out from the bottom of the stream, piled along the edge of the bank and the stream was given an artificially high bank. This has been done two or three times, until at the present time, between Schuyler avenue and the turnpike, the bed of the stream is in most places higher than the level of the surrounding meadow, and the water is kept in this sewage stream by artificial banks made up of pasty sewage.

It goes without saying that winter frosts and the work of muskrats cut through the banks here and there, and the water instead of running through the stream and into the Passaic river, spreads over the meadow. This means acres of marsh land flooded with sewage during a large portion of the summer, furnishing ideal

eeding places for mosquitoes of all kinds, and under conditions at make it simply impossible for us to deal with them.

There are at least a dozen places on the west bank of Franck's reek where there are breaks through which the Kearny sewage ows through the creek bank over on to the meadows and forms ewage pools. Most of the mosquitoes that breed on that side are resh water mosquitoes—house mosquitoes, malarial mosquitoes nd that type of mosquitoes that we know as *sylvestris*.

On the east bank of Franck's creek there are not so many breaks; he amount of sewage is not so great and the species that are bred here are the salt marsh forms, *cantator* and *sollicitans*. The bulk f all salt marsh mosquitoes that are found in the North Jersey owns after midsummer come from this territory.

It is utterly impossible for this service to do anything to remedy he condition that exists here. The matter has been brought to he attention of the local board of health and has been brought o the attention of the municipal and State authorities. They are ully advised of just exactly what the trouble is and what must e done, but up to the present time no disposition has been shown o do away with the trouble.

The conditions are not beyond control. It would require first f all a cleaning out of Franck's creek from the point where the ewer water enters it at the meadow to a depth of six feet at least, unning uniform to the Passaic river and for the full width of the reek. That would be sufficient to take all the water that would ome into the creek from the sewers and also the surface water om the meadow. At the entrance into the Passaic river there ould be a receiving basin of 50 feet square and 10 feet in depth, ith a rotary pump from which the sewage received through the annel of the creek could be pumped into the river continuously. hat would render the flow independent of tide, and would take erything that would come down the creek under all circumances. It would prevent the clogging of the stream and it would ep a continuous circulation of water, so as to prevent anywhere e covering that would permit the breeding of mosquitoes.

Something of that sort is needed as a sanitary measure. As e matter stands at the present time Kearny maintains a nuisance at is a disgrace to its own civilization and to the civilization of e State in which it is allowed to occur. Incidentally, nothing at can be done in this section of the State will do away with the

mosquito pest completely so long as this condition of affairs is permitted to remain.

One thing offered a chance for getting some at least of the surplus water off this Franck's creek meadow area. If the underlying subterranum was gravelly and porous there was a chance of opening up an underground drain, or series of drains, that would take off the surface water. The surface itself was covered with from six to eight inches of solid slime and mud which, baked to a dry leathery consistence in the sun and became tough and leathery under the influence of moisture, impervious in each case to ordinary drainage.

The Du Pont Powder Company was advertising dynamite for agricultural purposes, and particularly for sub-soil drainage and for deep ditching, and it occurred to me that possibly we might be able to use the dynamite to open a way out for this surface water. I therefore communicated with the Du Pont Powder Company at Wilmington, Delaware, and for a period of several months was in communication with their experts and operatives in a line of work in which they furnished all the labor and technical skill, while, on behalf of the State, I paid for the material used. The Kearny board of health co-operated locally, and the inspector, Mr. Geissler, deserves especial credit for the efforts that he made to further the work that was done on the meadow.

Briefly stated, the idea was that a series of ponds would be blown into the marsh, parallel with Franck's Creek, at as great a depth as we could conveniently place them, with the idea that, if possible, underground water courses would be opened up and the water taken away and carried off through subterranean channels relieving the creek, if possible; but at all events the surrounding surface area and preventing the local breeding.

It was not until the last days of June that everything was in final readiness for the blastings, and then the authorities of the surrounding boards of health and the representatives of the various newspapers were invited to attend the shooting of the first ponds. A series of altogether some twelve or fifteen ponds was put in covering a distance of nearly half a mile, the deepest of the ponds about 10 feet in depth and the largest of them nearly 30 feet in diameter. They average, however, considerably smaller than that, and in every case they filled with water very shortly after the holes

were blown. Very little influence was exercised upon the surrounding drainage. At no point was there any subterranean channels reached, and nowhere did we succeed in taking off any considerable amount of surface water.

It was noticed that the waters in these ponds cleared very rapidly. They were tested chemically at the laboratory, were found to be very strongly acid in reaction, to have a very large percentage of iron in solution, and that they would not support either fish or wrigglers for more than a short period at a time. Attempting to stock these ponds with fish, Mr. Henry H. Brehme found that he could not make killies live in any of them for a longer period than twenty minutes, and at no time during his collecting did he ever find larvæ or pupæ in these ponds in any considerable numbers. There might be larvæ and pupæ in the water among the roots and grasses surrounding the ponds, but in the ponds themselves there would be little or no breeding going on, and the ponds as a whole could be considered as safe.

The cost of making the experiments amounted to about one hundred dollars, and while the experiments were failures, the money was well spent in view of the information that was obtained in the course of the work that was done.

Point-No-Point.

This meadow has been under constant observation practically all season by Messrs. Henry and Herman Brehme, and whenever any breeding had been found Mr. Dobbins was notified. Mr. Dobbins undertook to keep this meadow free from breeding and fulfilled his contract in that respect very satisfactorily.

Up to the present year all the sand that had been dumped into this meadow had come from the Passaic river, and rather more than half of the meadow has been made entirely safe by a covering that brought it up to above ordinary high tide level. There was a nasty stretch below the point reached by the filling and along the line of the Hackensack river, and it was realized that until this could be reached by filling there would be some breeding going on at all times. Nevertheless even this could be reached to a very considerable extent by the proper use of oil, and during the season

of 1910 the co-operation of the Jersey City and Newark authorities kept matters in very decent shape.

In 1911 arrangements were made by which one of the dredges was placed in the Hackensack river and some filling was done from that side. This improved matters very materially, because even where it did not entirely do away with breeding places it did cover an enormous number of eggs, and it made the oiling of some of the places a very much simpler and more satisfactory matter.

The East Jersey Water Company has a pipe line that crosses this meadow, and there are about eighty joints or places where jointings are made, and at each of these a hole is dug to give room to get at the joints conveniently. These holes are left open permanently, and they furnished ideal breeding places throughout the summer that had to be continuously looked after by Mr. Dolbins's men. Mr. Delaney has put himself into communication with the officials of the company and has tried to get them to see the importance of looking after these places, and another season it will not be necessary to do this sort of work at least.

Furthermore, the filling from the Hackensack river is going on now very rapidly and very large areas of ground are becoming sand covered. This has buried millions of eggs of *sollicitans* and *cantator,* which will, of course, never hatch, and it will do away with breeding places to just that extent. With this area covered, as it will be before frost, the last of the larger areas of salt marsh that can be considered as dangerous breeding points for supplying Jersey City and Newark may be considered as practically eliminated. It leaves us with the Kearny problem as the only one of considerable extent in this section to be dealt with.

Newark Salt Marsh.

The fact that this meadow had been allowed to get into bad condition by the Newark authorities was realized during the winter of 1910–'11, and several inspections were made to determine exactly what should be done by the city and what could be done to help out by the State.

There were two sections at Waverly and at Maple Island where the original ditching was not as complete as it should have been, and developments since the ditching work was first done had turned an originally rather good part of the meadow into a bad

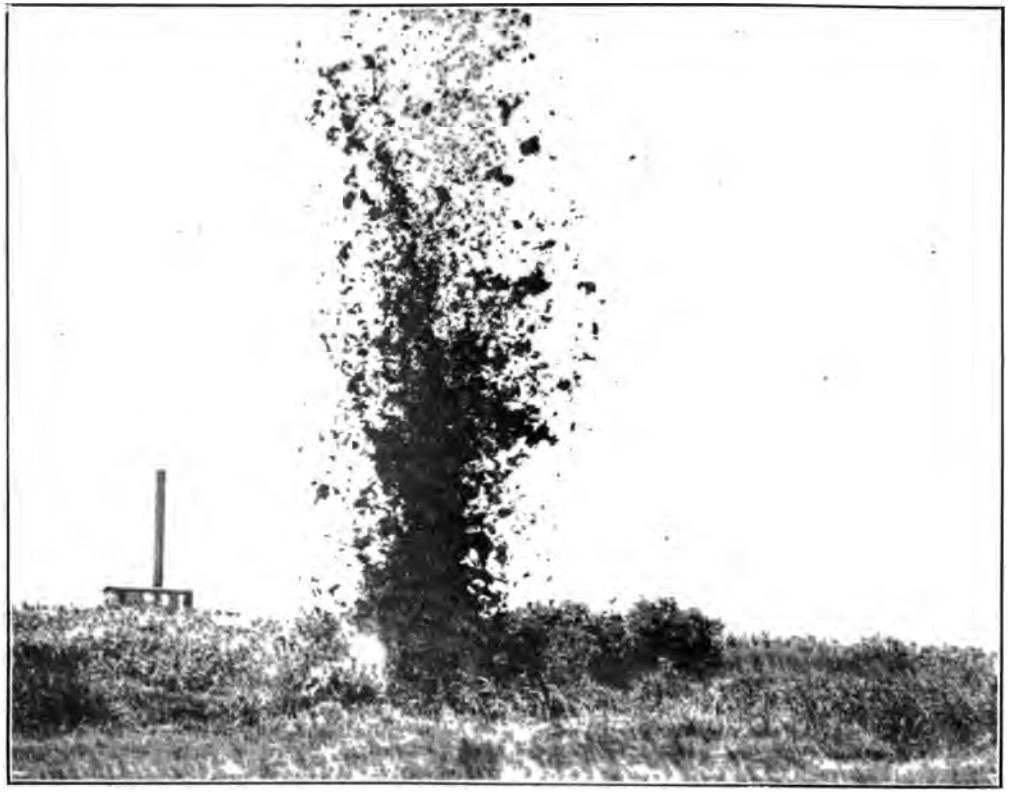


Figure 5.
The Dynamite Explosion. From Newark Star of June 29th, 1911.

breeder. There was a section, therefore, totaling just about two thousand dollars that could be reasonably charged against the State, and arrangements were made to have this work done prior to the breeding season in the middle of May.

On the other hand, there was a large area of territory properly ditched, but neglected by the city, where the ditches had been allowed to fill up with soft mud, and these it was realized should be charged against the city and should be cleansed by city work. To this work Mr. Dobbins refers in his report and refers as if the ditching relieved at that time was ditching originally put in by the State, which is an erroneous inference.

Most of the ditches referred to there were put in thirty years ago by haymakers and others who used the meadows for their own purposes at that time, and allowed them to fill up with soft mud thereafter. Some fourteen men were put upon this territory. The work was done under the supervision of an ordinary city foreman by day's work and was sloppy in every way. It was careless and cost altogether too much for what was finally accomplished. In the event, a small brood did get out in that territory, and it was necessary to take the men off too soon for the best interests of the meadow.

On the other hand, the work done by the State was done under contract. Over one hundred thousand feet of new ditching was put in, ditches thirty inches deep by ten inches wide, and every particle of water was taken from the marsh before the breeding season began. In the Maple Island and in the Waverly sections two hundred thousand feet of ditching can be added to the total amount, and practically no breeding went on there throughout the season.

Another mistake that was made on the salt marsh by the city gang was that the entire force was taken off before the middle of May, and therefore the forming pools in the incompletely cleaned sections were not kept under the necessary supervision, and from time to time, on high tides and heavy rains, small broods emerged and worked their way into the city that would have been unnecessary had they been kept under the supervision more carefully.

Practically no supervision of the salt marshes was maintained by the city of Newark during the summer. The only supervision that was maintained by the State was a monthly inspection made by the writer, Mr. Herman H. Brehme, for the benefit of the

North Jersey Mosquito Extermination League, and the outcome of the inspection was at each meeting read before this league. At this time Mr. Dobbins was notified of blockages and of interferences, but naturally enough no attempt was made to keep his meadows cleaned for him, nor to notify the persons concerned in the blockages.

Altogether up to the middle of September thirty-eight inspections were made by the State by the two inspectors employed in the city and on the marshes, and, so far as the meadows are concerned, everything was found in good condition until after the middle of September, when the high tides and heavy rains kept the surface water covered continuously. This, however, adds nothing to the danger, and although the meadows are continuously water covered, they are also covered with fish and there is little or no breeding going on over the surface.

So far as the salt marsh problem is concerned on the Newark meadows, that may be considered as under very good control, except where it is interfered with by the building or filling arrangements, or by other arrangements connected with the progress of improving the city or its surroundings. It is perhaps questionable whether it is a good plan to connect all the pools with ditches. It will tend to cut up the meadow a great deal more than is the case at the present time without adding much to its drainage, and it will tend to make it much more difficult for the haymakers and others who use the meadows for agricultural purposes.

Elizabeth Meadows.

During the early part of the season, the work of cleaning the ditches on the Elizabeth meadows was done under the directions of Mr. Louis J. Richards, but largely with funds contributed by the State. Some funds, however, were collected by Mr. Richards, and for a period of nearly two months a large gang of men was kept busy in cleaning up meadow areas that had been ditched in years gone by, but for one reason or another had not been thoroughly cleaned up since that time.

As the first spring brood developed it became obvious that Mr. Richards's gang would not be sufficient to complete the work that was necessary, and I therefore authorized Mr. Brehme to engage Mr. Manahan with a gang of ten men to put in a few days of addi-

tional labor, which helped matters out and started the season in good condition. There was altogether about seven weeks of work done, much of it contract work, and therefore more thorough and more rapidly done than the work on Newark, and fully half a million feet of ditching was gone over and cleaned during that period.

In previous reports the conditions of the Great Island section have been sufficiently set out, and it has been explained how it is that this territory cannot be made to drain under normal conditions. The arrangement that was made during the present season was, that Mr. Richards was to furnish the labor and that I was to furnish the material and the machinery to cover the Great Island section, and determine whether it was not possible to keep that oil covered, and thus to practically prevent mosquito breeding, even in the territory that could not be drained.

On April 21st, we first found a very heavy brood of larvæ in all the pools around the island; enough to flood the city if they had been allowed to get out, and in such position that it was simply impossible to drain the insects off. Two days' work with oil sprayers sufficed to go over the entire territory, and as the work was supervised by Mr. Richards and Mr. Brehme, it was thoroughly done, so that on the 26th the report was that practically every larva on that entire section was killed off.

Conditions during the early part of the season were good there, and not until June 3d was a second brood reported on this meadow. This brood was not quite so promptly treated as should have been done, and the result was that some mosquitoes were permitted to escape into the city from that territory; but very few actually did escape, and in the latter part of July we got ahead of a brood about the 28th of that month from which probably not a single specimen got into the city—an unheard of record and one which kept that section of the city entirely free from marsh mosquitoes at that season of the summer.

For the balance of the summer and until well along in September the meadow was kept under supervision, for it was established that there is no difficulty whatever in keeping the mosquitoes on the Great Island section of the Elizabeth meadow in complete subjection. It means some waste work, and it means doing over some work twice to suit weather conditions; but the mosquitoes can be absolutely kept out of the city from this territory.

On the other hand, it is a question whether the matter ought to

be allowed to go along in just the way in which it is going at the present time, and to be a burden for years to come upon the city and upon the administration of the local boards of health. The railroad will want increased concessions across the marshes. They will have to have them. They need the facilities and they need wider and possibly even more solid embankments than they have at the present time. That means in every case the filling up of additional ditches and further interference with drainage. The present single track interference across the meadow will not be sufficient for long, and any further interference will of necessity make matters worse and worse.

It seems to me that it would be the part of good engineering and good policy on the part of the railroad company, and certainly the part of good policy on the part of the city, to insist upon planning their work at the present time in such a way as to permit of the cross drainage of this meadow from the highland at the west to the bay at the east. There will not need to be more than one or two cuts across the embankment, and if those cuts are put in at the proper places and properly guarded they will in no way weaken the railroad line of way, and they will make possible the complete drainage of that quagmire that now lies west of the New Jersey Central railroad embankment across the Newark and Elizabeth meadows.

Linden Meadow.

In the Report for 1910 attention was called to the fact that in the course of improvements made on the meadows a sewer was cut carrying drainage from the highland to the bay, and without any regard whatever to the drainage conditions that had been established by the State in its mosquito work. Not the slightest attempt was made to maintain the continuity of the ditches, and when the sewer was completed one complete section of the salt marsh was again practically cut off from all connection with tide water. The condition was discovered by Mr. Herman H. Brehme, my inspector, soon enough, and the attention of the Linden board of health was called to the matter. They acknowledged the condition, but further than that I could not get them to go.

In the spring of 1911 I had Mr. Brehme make another careful survey of the territory. It was found that the matter was worse

than before. The gradual packing in of the material in the sewer ditch continuing to destroy the sepage through the line of that ditch, leaving a considerable meadow area undrained.

It was determined from this survey that it would require five hundred dollars ($500) to put the meadow back into good condition, and the attention of the Linden board of health was called to the matter once more. They were also advised that there was a terrifically large brood of larvæ on the meadow at that time, growing very fast, and promising within a few days a good old fashioned flight of salt marsh mosquitoes for Linden and its surroundings.

The board met this condition promptly. I had offered to contribute two hundred and fifty dollars ($250) out of the State funds if the board would do the same, and would give the contract for doing the work to Mr. Manahan. Mr. Manahan had agreed to do the work for five hundred dollars and to accept the Linden township as one of the contractors, if they would give him a free hand to go ahead promptly and without hinderance.

This they did, and by putting on a very large gang under the general direction of Mr. Brehme, the danger spots were first of all attacked, and relief was given to the sections on which the greatest number of larvæ were found breeding. The rest of the work was done in a more leisurely fashion, and, on the whole, surprisingly few mosquitoes got out of this territory, considering conditions as they existed during the early days of May.

There was sufficient money to do quite a bit of cleaning of ditches, and it was all spent in that way, so that during the season of 1911 the Linden meadow remained in good condition, and with very few of the salt marsh pests hatching. Unless some other "improvements" are started this meadow will remain in good condition for another year or two to come, and it certainly is in very decent condition at the present time.

Woodbridge and Sewaren Meadows.

These are meadows that are always at the danger point, and which we have been keeping under rather close observation. Three inspections were therefore made by Mr. Brehme during the season of 1911, but conditions on the whole were always found pretty

fair. Some sods were found in some of the ditches, but always lying in such a way that they did not interfere with the drainage.

It appears from the inspections made that the area between the New York and Long Branch railroad and the county road should get a little additional ditching. The spur ditches that were originally put in from the main ditches in this territory have filled up considerably, and a few new ones should be cut where needed. It is probable that twenty-five dollars ($25) would pay for all the work needed on this area.

The territory near Boynton Beach, which was partially blocked by pumping sand on it from Woodbridge creek, as we reported in 1910, is being gradually filled in altogether, and the breeding places are being eliminated in consequence.

The Barber Asphalt Company has built a plant on the west side of the New York and Long Branch railroad, and while filling in is still going on around the plant and its vicinity, no drainage has thus far been interfered with, but the place will have to be watched, and it is one of those that can be very easily turned into a very nasty and unsatisfactory breeding territory.

Carteret Meadow.

This belongs to the same series as the meadows just reported upon, and might have been left to take its chances with them, because it seemed to be in about the same condition as a whole; but more sods had floated into the ditches and there seemed to be a greater amount of interference with the drainage. It was deemed wise therefore to spend twenty-five dollars ($25) in cleaning up this territory, and that was done in early May. After that the drainage conditions were exceedingly good, and while no very close examinations were made there was nothing to indicate, at any time later in the season, that mosquito breeding was going on to any considerable extent.

Perth Amboy to Maurer.

No city has been more active during the season in its fight against the mosquito pest than Perth Amboy, and the local board of health has used its powers to the full extent in every direction.

The result is that some extremely good effects have been secured, and while there have been undoubtedly a great many mosquitoes in Perth Amboy, there have been not nearly so many as in years gone by, and the conditions are better for future work.

Perth Amboy is now almost in the condition of having most of its outside breeding places under control. The city, on the other hand, is located in a district in which there is an abundance of salt marsh and fresh water swamps and a great deal of low land. It has a large population of foreigners, some of them of the most ignorant description, and it is a population that will breed mosquitoes on the least provocation, or without any provocation at all.

Under the circumstances the problem before the local board of health is a serious one, and its organization has not been such as to measure up to it. This is not a criticism of the board, because they have done everything that it was in their power to do. On three occasions Mr. Herman H. Brehme went over the ground with one or the other of the officers of the board, and I went over the territory personally with Mr. Brehme, besides going over the ground myself from time to time as a trip through Perth Amboy was necessitated by my trips through the State for other purposes.

The Maurer meadow is practically within Perth Amboy, and while that territory has been ditched the ditches do not work well for some reason and block easily. On April 19th, Mr. Brehme was on this meadow with Mr. Kaletsch, the then president of the Perth Amboy board of health, and his attention was called to the conditions there. Within two hours afterward these conditions were being improved, and Mr. Brehme reports that during the balance of the season the Maurer meadow remained in very fair shape.

There is no doubt, however, that Boynton Beach, Sewaren, Woodbridge and Carteret add to Perth Amboy's supply of salt marsh species from time to time, and occasionally the Raritan meadows are also in fault.

Raritan Meadows.

I have a pretty good tab on the condition of the Raritan meadows on my own front porch at New Brunswick. Whenever any mosquitoes breed on that meadow, no matter how small their number, they find their way along the river and they visit me at the

curve in the river where my house is situated. It seems to form a natural line of flight for them, and I always have gotten the full benefit of whatever happened down "on the banks of the old Raritan." Before my house was built, it was almost impossible to stay on the lot, because of the number of mosquitoes that scared off prospective builders, and later, when I established a garden, there were parts of the garden into which I never went at certain seasons of the year, unless it was absolutely necessary.

Conditions have changed. Since the Raritan marshes were ditched we rarely see *sollicitans* at all at New Brunswick. In some seasons it is practically non-existent. *Cantator* maintains itself and at times is offensively prevalent on the front porch. Then I know that something has happened down the river, and I can send Mr. Brehme down with positive instructions to find the source of the trouble rather than instructions to find out whether there is trouble.

So, it happened this spring, when, after practical freedom from mosquitoes during the early months, specimens began to make their appearance in June. Mr. Brehme reports altogether four inspections of these Raritan meadows. During the early part of the season everything was in good shape; the ditching was working well, the meadows had been largely burnt over and were dry, and on the north side practically every ditch and pool was free from standing water and absolutely without larvæ.

Conditions changed in June. The tides began to run high, the winds became adverse and there was rain enough to keep the upper section of the meadow water soaked. It was not that the drainage system was bad, but there simply was too much water to be carried off by the valley. The only help that could have been given, would have been to deepen the river, and that, of course, we were not in condition to do. While there was a heavy brood of killies in the streams there were not enough of them to take care of all the larvæ that ran up into the grassy holes near the edges of the highland, and the result was that in June there was a brood of *cantator* that got on the wing and into the surrounding territory.

After the wet conditions had disappeared the meadow gradually dried up again and remained dry until September, when there was a reappearance of the same conditions and the mosquitoes again made their appearance at New Brunswick. At that time I was in a condition when I did not care very much whether the mosquitoes

were abundant or not; but I do know that they were not plentiful enough to be troublesome in doors, because I had many a sleepless night, which would have been made seriously worse by the presence of mosquitoes.

There are ditches enough on the meadow. In some sections a little cleaning out of the ditches would do no harm, but the trouble is rather a general inability on the part of the valley to carry off all the water that accumulates in it at a certain season. There is a terrific amount of water that comes down the stream during a period of heavy rains, and that volume of water is increasing rather than decreasing each year as the surface wash becomes more intense; and at the same time the river shallows as the result of continuous sedimentation and causes a spreading out of the water over a greater area.

What has been accomplished up to the present time has been the almost complete elimination of *sollicitans*, the reduction of *cantator* to such a point that only a fraction of its former virulence remains, and each year it is becoming reduced in numbers, so that even this species is losing its hold, and would lose frightfully after two or three favorable seasons. These favorable seasons meaning not seasons of continuous drought, but simply seasons without excessive rains grouped at one time.

Cheesequake Meadow.

Conditions on this meadow were good all season with the exception of the middle of June, when a brood got out, due to rains and tides, and again late in September when a light brood got out, due to the blocking of one ditch near the snipe grounds.

The first inspection was made on May 4th. At that time the meadow was in perfect shape, not a single larva was found on it and the ditches were working to perfection.

No mosquitoes got off this meadow until the middle of June, and then the weather conditions were such that the ditches were not capable of taking the tons of water that shot down the hillsides from the heavy rains and the water that backed up with the high tides. After this brood died off, which was in a few days, nothing hatched from that meadow again until the middle of September, when there was a series of high tides and rains that kept the

meadow wet, and the blocking of one ditch to keep water on the scalds to shoot snipe.

The blocking of that ditch takes place every season, and a watch will have to be kept on that place in the gunning season. The blocking of this one ditch means that nearly an area of two acres is covered with water, and in such a space a good supply of mosquitoes can emerge.

Morgan or Lawrence Harbor is becoming a great summer resort. Four years ago, or before the drainage work on the Cheesequake meadow was done, only a few natives lived at Morgan, and these were only the bridge tenders and boathouse keepers. The second year after the work was done a few campers pitched their tents. These increased in numbers with a few bungalows in 1910, which was due to the fact that what was once an uninhabited mosquito section was turned into a mosquitoless town. Where nobody lived in 1907, thirty-three tents and nineteen bungalows were up during the season of 1911.

While the salt marsh mosquitoes are under control, the *pipiens* are getting a hold due to the number of barrels and tubs used by the campers, and it will mean that these people who have barrels, &c., on their premises will have to be taught how to keep their water receptacles either covered with bags or screened, or they will have to suffer from this little trouble maker.

Marquis Creek Meadow.

This meadow was ditched under great difficulties in 1907, many spots being found that contained red sand, and which was thought at the time would not hold a ditch.

The ditches after nearly four years were found to be in as good a condition as at the time they were put in.

This area is only about eighty acres in size, but there were some ideal mosquito breeding places on it, which have been so thoroughly wiped out that no breeding has taken place since the work was done.

The *Cliffwood, Matawan, Keyport, Lorillard, Keensbury, Belford* and *Atlantic Highlands meadows* were only inspected once during the last season. Everything was good from the reports that the natives gave. The only time that they were troubled with mosquitoes was about the middle of June, which was the same time that mosquitoes got out on the meadows further north.

Monmouth Beach.

This was one of the first meadows that was undertaken in the State, and the ditches that were put in there were those that followed closely on the old Massachusetts line of six inches by twenty-four inches. The work was well done and for several years was satisfactory, but there was considerable wash from the steamers, and it was found that it needed rather more looking after than was justifiable in what purported to be a permanent piece of work.

Under the circumstances the whole matter was taken in hand again by the association that did the work in the beginning, and what was left of the meadow has been re-ditched with ditches cut to the modern depth of thirty inches and width of ten inches. A good portion of the territory that was originally improved along the Shrewsbury by this first work has been permanently reclaimed, and the entire character of the surroundings has been changed.

Water Witch.

The problem at Water Witch includes really that at Highlands and practically that which extends from the landing at Atlantic Highlands to the Highlands station. There is here a stretch of marsh land at the foot of the bluff, a small part of it typical salt marsh, another small area at the extreme base of the bluff typical fresh water swamp, and intervening spaces which may be dirty in either direction.

The largest natural breeding area is for salt marsh mosquitoes and extends irregularly into the bay. It is being vigorously improved, a goodly portion of it has been filled up and reclaimed and camps are being built on it. The length of time that this will remain a mosquito breeding territory is necessarily very short. Every year sees additional buildings added and additional filling done.

Just back of this first line of improvement and between this line and the railroad right of way is a swampy area, in most part fresh water swamp and in goodly part territory that will breed not only ordinary house mosquitoes but the *Anopheles* or malarial mosquitoes as well. Water courses come down the bluff and down the elevation which are not carried off through any natural streams

into the bay, but are allowed to lose themselves in this low swampy area through which the railroad runs. Two or three ice ponds assist in giving character to the territory and help in fixing the general lay-out of the land and water.

No settlements are taking place at the foot of the hill or along the direct line of the railroad, but along the top of the hill and everywhere on the crest of the elevation expensive and elaborate residences are being raised.

Sanitary conditions on the hill are good as a whole. The sanitary conditions on the flats, where the campers are during the summer, are generally fair and can be made good very readily. Sanitary conditions in the intermediate spaces are very poor. The residents on the hill section of Water Witch have taken this matter in hand and are trying to improve conditions. They have accomplished a great deal and they will undoubtedly accomplish a great deal more.

With a little co-operation on the part of the local authorities and of the railroad operating between the pier and Atlantic Highlands, matters can be very much more improved, and this whole territory can be almost completely freed from mosquitoes at a very small sum of money and kept freed thereafter at the expenditure of an exceedingly small sum annually.

Manasquan.

Only two inspections were made on this meadow. On the first inspection, which was on July 18th, the meadow was found in superb condition. Everything was working nicely and no larvæ or adults were found, and from the reports of the natives no mosquitoes were noticed up to that time.

Conditions were found different on the second inspection, which was made on August 2d. The tides in that section of the State had been running high for a week or ten days before this inspection was made, and while the meadow was found dry and in good working order, such an enormous amount of water was thrown over the meadow during this series of high tides that the ditches could not drain it off fast enough, and the pools were kept wet enough to enable a half-starved brood of *sollicitans* to hatch. But

fortunately most of these stayed on the meadow, and the inhabitants were not troubled much.

Conditions were good until late September, when the same conditions that existed in early August again reappeared.

Barnegat Bay Shore.

The importance of Barnegat bay as a summer resort and the enormous possibilities of that territory must be realized by every person that makes even the most casual study of the summer resort problem, and no one who spends even a small portion of the summer at any of the resorts along the Jersey shore can fail to appreciate the importance of the mosquito problem.

It is literally within the bounds of truth to say that the mosquitoes have killed off several flourishing settlements, and that they have absolutely destroyed millions in property values along this coast. Nevertheless, and in spite of the past, settlements are slowly increasing, and as improvements are being made here and there, their natural influence in reducing the quantity of the pest induces the further extension of the settlements.

Bay Head, at the northern end of Barnegat bay, marks a point of division along the coast, is a narrow strip with a beautiful sloping beach that extends for miles with comparatively few breaks to Cape May. This strip varies in width and a good deal in its general make-up. Essentially, however, it is a ridge of sand hills, the western shore sloping very gradually into the waters of Barnegat bay and forming a salt marsh. At the present time there is no outlet at the northern end of Barnegat bay into the ocean. There is no tide, the waters of the Metedoconk river keep the upper end of the bay practically fresh, and a true salt marsh does not really exist at Bay Head and its surroundings except as a remnant. The bay widens, and there is a broad fringe of salt marsh extending along its western shore, forming the eastern border of the highland proper. On both shores of Barnegat bay, therefore, there is salt marsh, and salt marsh under conditions which favor the development of mosquitoes to the utmost.

In the course of the work that has been done by my office the entire stretch of salt marsh lying along the west coast of the bay extending from Bay Head to Toms River, has been ditched and

drained and the salt marsh breeding places have been pretty thoroughly eliminated from a goodly portion of that area. Mr. Brehme's report on the territory between Bay Head and Toms River speaks for itself. It gives the existing conditions and shows what is necessary to bring the area into satisfactory condition.

The conditions along the narrow shore strip extending from Bay Head to Seaside Park were decidedly more complicated and more puzzling than those on the main land, and I hesitated about taking them up until the present year. In the first place, before the new State road, which now extends from Bay Head to Seaside Park, was completed, there was nothing in the way of a grade established or a continuous road, except the line of the railroad extending between the same points and turning west at Seaside Park across Barnegat bay for Toms River and Philadelphia. At Seaside Park some drainage work was done years ago, and conditions were decently good, so far as mosquitoes were concerned. At Berkeley and Ortley the places had been killed off by the mosquitoes, and the other places along the line of the railroad had just barely maintained themselves.

I had covered this territory myself, on foot as well as in the train, and it had been covered by some of my assistants as well. I knew just exactly what the breeding conditions were and knew precisely how very difficult it would be to do permanent work in a territory where a permanent supervision could not be maintained.

The line of the railroad extending parallel with the ridge of the sand hills is built back of the sand hills, and as close as is deemed safe to the edge of the salt marsh. This shelters the embankment from the sea, and the whole line of way is protected by sand hills directly on the coast. Every spur and every strip of sand that extends into the marsh is cut by the railroad, and equally every spur of marsh that extends into the sand hills tends to become blocked by the railroad embankment if it is not directly and deliberately blocked when the embankment is put in.

In consequence, there is, to the west of the railroad, a tolerably good stretch of salt marsh which is easily ditched and easily drained and freed from mosquito breeding places. East of the railroad and between the embankment and the sand hills there are pockets of marsh area that sometimes hold water for days and weeks and furnish ideal breeding places for mosquitoes. Among

the sand hills themselves, where the shore strip becomes rather wide, some of the low places become sodden, so that the water does not drain off readily and become covered with a growth of grass or the like. These also, under favorable conditions, will breed mosquitoes in great quantities, and that sort of breeding place may occur anywhere along the line, and I know does occur at numerous points between Bay Head and Seaside Park.

As a rule, in the laying out of improvements, the salt marsh area, particularly where it is at all broad, is left out of consideration and the improvement consists of a leveling of the sand hills extending back as far as the line of the railroad, or a little beyond. At the present time, the tendency is to complete the work between the shore line and the State road, and to do only what is absolutely necessary between the State road and the line of the railroad, leaving the territory between the railroad and the bay entirely undrained. The natural result is that it has become an exceedingly expensive proposition to deal with the territory, and it has seemed to me not an appropriated expenditure of the State's money to benefit a line of territory that will be put upon the market at high prices within a few years and without any return to the funds expended by the State.

I decided, therefore, from the beginning, to omit from all scheme of improvement the whole territory between the shore and the State road, and on this territory the number of breeding places is really very small, except in a few favored localities, such as Ortley, where breeding places extend between the hills clear to the shore. However, the owners of the lots there can, by combining and contributing a not too large sum per individual, secure practically complete immunity.

I have also decided to omit work in most places between the State road and the line of the railroad, because there was no sort of guarantee that this work would not be interfered with by "improvements" as soon as they began to be made, and I concluded that it would be time enough to take part in these improvements when they were put upon something like a permanent basis by either some land company or by some borough or other municipality taking up the work.

Only where a piece of genuine salt marsh extends into this intermediate strip have I taken up the work at that point. On the other hand, practically all the territory between the railroad and the

shores of the bay have been drained and ditched during the past year or two between Bay Head and Seaside Park.

One of the reasons that has decided in the action taken, is the condition of affairs found developing at Bay Head. Here there was an area of salt marsh that extended directly back for a considerable distance. It was completely ditched and the drainage extended back so as to take the water to the edge of the highland. While dredging work was going on, the yacht club and other organizations interested, arranged for the filling of a section of that territory extending from the edge of the bay part way to the highland. So far as the filling extended, the work was thoroughly done; the breeding places were completely abolished, but there has been left a basin, which is now completely removed from the effects of salt water, will grow up with fresh water plants, and will form an ideal place for breeding *Anopheles* and the ordinary house or *pipiens* mosquito. Conditions just at that point are now really worse than they were before, and the whole thing might have been avoided by spending just a few dollars more at the time the dredge was pumping in the sand. It will cost now several hundred dollars to do the work that could have been done for probably less than one hundred dollars at the time the original undertaking was being carried on.

Brick Township.

This strip extends from Mantoloking on the north to Dover township on the south. The work here was started August 1st with twelve men. The meadow was first looked over in May, and again in July, and it was estimated that 40,000 feet would be required to drain all the danger points, and this proved to be the case. The first ditches that were cut near the northern line were found to have a layer of sand about six inches below the surface, and this layer was about five inches in depth. Then a genuine marsh soil was encountered, which could be cut down to the normal thirty-inch depth and give us good outlets for our ditches.

Two weeks before the work was started the meadow was flooded by a southeasterly tide, and this remained long enough to give rise to a large brood of *sollicitans* which, while they were intensely annoying, had the advantage of locating the breeding places as the work went on. August 5th there was another high tide, which did not prevent the continuation of the work; but again gave us

opportunity to locate the danger areas, and in fact during the whole period of time that work was under way on the meadow, occasional tides or slight storms kept the meadow in such condition as to point out the danger territory.

Most of the ditches were run into creeks or coves wherever such existed. We have found by practical experience that where we have natural creeks or ditches they seem to remain open indefinitely, and for some reason or other do not become blocked with seaweed or other rubbish. The meadow was so very level that practically no filling had to be done, and ditches could be run to all danger points. The full amount of 40,000 feet of ditches was required, and the work was finished, inspected and found satisfactory on August 22d. The cost amounted to nine hundred and thirty-five dollars ($935).

Dover Township.

The work done in this township was between Barnegat bay and the ocean, and started at the Brick township line on the north and finished up at the Seaside Park line on the south. The borough of Lavallette lies about midway between these two lines, and owing to the impossibility of obtaining action by the board of health of that borough, the territory within its boundaries was not taken in hand with the rest of the work.

Work was started on the northern section September 14th, with twenty men under an agreement with Mr. Jesse P. Manahan. In a general way matters were found in much the same condition that we found them on the Brick township meadow. There was no difficulty in locating bad places, and to make things worse high tides set in, which put the meadow a foot under water for a part of the time. These tides on the Barnegat meadows are principally backed up water. Drainage comes in from the surrounding territory, and there is no way for it to get out into the sea. The number of inlets or outlets are so small and they are so narrow that it is simply impossible for the water to get away, and long before the water can run out the flood tide is again in control, and therefore it frequently happens that a continuous storm will maintain an apparently level tide covering the entire meadow. However, that is the condition under which part of the work on this territory had to be done.

The lines were run after the ditches were staked out, and while they were lying nearly a foot under water, nevertheless good and straight ditches were cut. The only disadvantage was that work was, of course, retarded. As it progressed toward the south conditions improved, the fall of the tide was greater, and part of the time the men were working dry shod.

In a good portion of this territory the meadow was very level and good and only had a few small depressions here and there; bad breeders, but so few in number that it was deemed wiser to fill them than to cut ditches. This, of course, is an advantage to the haymakers, which they appreciate and which they perhaps consider of much greater importance than it really is.

The work between the Dover and Brick township lines and the north line of Lavallette was finished September 20th, and a total of 45,000 feet were put in. Good drainage was assured over this whole area, which, as in the case of the other territory, was principally to the west of the railroad line.

The section south of the Lavallette line was then taken up and some very bad breeding places were found. The pools indeed were black with larvæ, and the men were set at once to work to get rid of the worst of these pools and get the larvæ into the bay for their own protection. It made it just so much easier for them to work and unnecessary to spend so much time fighting mosquitoes.

The ditches were staked out here and the work proceeded very rapidly, because weather conditions were favorable, and there were no adverse conditions of any kind. North of Ortley the meadow is composed very largely of genuine marsh land with some spots of sand. South of that point more sand was found, and in some places was so hard the ditches could not be brought down lower than 20 inches. These ditches run on the grade, however, and drain to the bottom of the meadow in all cases. A total of 40,000 feet of ditching was put on these meadows, and all of this was on the west side of the railroad. This work was finished on September 28th, inspected on the 29th and found satisfactory. The total cost was seventeen hundred dollars ($1,700).

Lacy and Berkeley Shore Strip.

ıe shore strip on which Seaside Park is situated and extend-
lown to Barnegat inlet, is very narrow and has no more than
arest fringe of salt marsh along the edge of Barnegat bay to
ɔuth of Seaside Park. It is so narrow south of Seaside Park
that it has not been deemed wise to put any of the State
ɜ into any work along the sand hills.
ıere are probably some places in that territory in which oc-
ıally some salt marsh mosquitoes breed; but they do that
r such unusually abnormal conditions that it would be impos-
without an expenditure of an altogether disproportionately
sum of money to avoid all danger, and the trouble is likely
me only either very early in the spring or very late in the
at a period when the interests of the resorts would suffer
Under the conditions as they stand it was decided to allow
ɔrs to remain as they are, and to put it up to the local au-
ɔies to make the necessary expenditures whenever the interests
ɔ various municipalities really demanded the expenditures.

Berkeley Township Meadow.

e contract for the work in Berkeley township covered 1,728
and was awarded to Mr. Jesse P. Manahan for six thousand
rs ($6,000) on August 3d. The specifications were sent to me
vere received on August 5th.
vent down to Barnegat pier on August 7th to look the meadow
and select the most convenient place to start the work. There
ɔome delay in bringing down the men, but the territory was
over with the foreman of the machine gang on the afternoon
ɔ 7th and on the 8th. It was found that the best place for the
ine work to start was on the meadow just south of the Falken-
meadow, which is about one-half mile south of the Pennsyl-
railroad. It was found after the machine had been brought
from Toms River that work could not be started for two or
days, as the steering gear was broken in bringing it down
gh the sand roads in the woods, and the hand gang had not
ı down on the afternoon of the 9th. The matter was there-
eft in the hands of the foreman who was told to start in case

the men would come, where the work was staked out. (I left with you for Newark on the 9th.)

I went down to Barnegat pier again on August 14th. At that time the work had started with 16 men who worked the hand tools and five men were working the machine. It was at first thought that the meadow would be hard and sandy; but this was not the case, and ditches could be easily cut to the depth of from 26 to 32 inches. The best feature about that meadow is that the ditches could be cut on a grade—that is, it was no trouble to cut down 30 or 32 inches—at the outlets, and although they could not be cut hardly any deeper than 26 inches towards the upland, the ditches had sufficient fall to take off all the water. The work with both machine and hand tools went along nicely, and by noon of the 18th, over 20,000 feet had been cut, and the biggest part were hand-tool ditches. The owners by that time had noticed what the work was to be, and it spread rapidly along the line that the meadows were being improved instead of being ruined, as was at first feared by some of the owners.

The meadow was then in a very dry condition, due to low tides and no rain for some time, and while it was difficult to tell just where the most dangerous points laid, it was made easier with the help of the owners, who knew all the low points and where water would lie the longest. The owners by this time were ready to show everything and assist wherever they could. The work was kept on down towards Sloope creek with the intention of bringing the men back if necessary after the first high tide or heavy rain. (I returned on the 18th, after staking out enough work to last four days.)

On August 22d I went down to Berkeley township again and the work that had been done, which by this time had reached all of 35,000 feet was looked over and found to be all right, and the 23d and 24th the meadow was gone over with Messrs. Veeder and Lewis, both owners of large tracts of meadow. Both were anxious to get their own meadow property ditched to the best advantage, but at the same time not to have too many ditches. The meadow was thoroughly gone over, and, while the original plan was changed somewhat to make it easier to drive over, yet at the same time to assure the same results as on the plan laid out, it required as many feet of ditching as the specifications called for and nothing was saved.

There are several wide ditches on the Veeder and Lewis meadows which had not been cleaned since the day that they were cut and these had to be cleaned down deep. These ditches were four to five feet in width, and while drainage could have been gotten sufficiently for the meadows bordering on the east and south of these old ditches without tapping them, nothing could have been done with the meadows that lay north and west of the ditches. If the narrow ditches had been cut right through these old ditches without first cleaning them they would have filled right up with the soft mud that would run in from the old ditches in a very short time, and the work would have been for naught. It required considerable labor, but this was the only way that it could be done.

The hand gang was increased to 20 men on the 23d, and on the 24th, which was the day I left, about 43,000 feet had been cut. Work was laid out to last both machine and hand gangs for four days. The hand gang was keeping ahead of the machine, as they had the advantage by the machine having to be shifted so often.

The next inspection was made on those meadows on the 29th, and up to that time the work was going along in good shape. Late that afternon a storm set in which was terrific and flooded the meadow, so that practically every portion of it was under water. Work had to stop for two days as it was a continuous downpour. While it made it unpleasant for the men it was to their ultimate advantage in securing good results. The good and dangerous places now had to show up in a few days. The work at this time was near Sloope creek and nearly 100,000 feet of ditching was put in. (I left for home on September 1st.)

Conditions were again looked over as far as the work had gone on September 6th, which was just about six days after the heavy downpour and high tides, and the rain alone amounted to seven inches of rise! The first thing that was done was to look for spots where the water had not drained off, and while a stretch of nearly two miles in length and from a half to a full mile in width had been ditched when weather conditions were so dry that very little could be done except by going over every foot and locating and taking a chance. With all those odds against us everything was found to be in the best working shape except two places, both of them on the Falkenburg meadow just south of the Pennsylvania railroad. The hand gang was taken back, and as every danger spot was now marked it was cleaned up in good shape. This par-

ticular meadow was watched up to September 29th, and although there had been several more high tides and rains on that meadow, the water would not stay more than four days at the longest, and then the meadow would be perfectly dry again. The water on the undrained meadow north of the Pennsylvania railroad and south of Sloope creek remained stagnant, there being no chance for it to run off, and on the 7th a terrific brood of mosquitoes got out on those two meadows.

While some doubt was cast upon the drainage work by this, it was readily proved where these pests bred and where they did not breed by taking them over both drained and undrained territory, where no larvæ were found.

The work on the Falkenburg meadow was finished two days later and the men were taken back to the Sloope creek section, and enough work was laid out to keep both machine and hand gangs busy for four days. Close to 150,000 feet were cut on September 8th. Work enough had been laid out on the south side of Sloope creek to keep the men busy until the 12th. On that day the work that was done was inspected and found to be all right, and then more work was laid out through that section. On the 14th practically the entire hand gang was taken over to Dover township, as the work on that territory was to be finished by October 1st. This left only the machine to do work down to Cedar creek, which is the line of Berkeley and Lacy townships. Such work as could be done by the machine was done, and the short ditches were left for the men to do when the Dover township work was finished. The machine work was inspected on September 21st-22d and 27th-28th. On both of these inspections the work was found to be satisfactory and additional work was laid out.

On October 7th the men returned from the Dover township work, and the section north of the Pennsylvania railroad in Berkeley township was taken up. This area was to be left until all the other work in Berkeley township had been finished, for the reason that a rumor was afloat that the man who hires this meadow from the Pennsylvania Railroad Company would not permit the work to be done, and for that reason the work was skipped to see what the man intended to do. It turned out, however, that all the talk that was going around about this matter was false, and Mr. Butler came down on the meadow while the work was going on, and was very glad that the meadow was going to be ditched. One part of

this meadow was so decayed that no ditch could be cut through to the bay, and drains had to be run from an old wide ditch to this soft place, and from there led into a large pond which empties into a creek. After this meadow was done, which took 20,000 feet, the men were taken back to Sloope creek, and the work of spurring, filling in of holes and cutting such ditches as could not be done by the machine, was finished up. I got down there on the 8th and went over the work and laid out more on the 12th and 13th to keep the men busy until the 17th.

While many obstacles were met with, high tides, the men stuck right to the work, often wading in water knee deep, and while it made it difficult to cut ditches under those circumstances, nevertheless every ditch was cut straight and deep, and just as well as if the meadow had been dry.

The biggest part of the meadow was found to be free of sand, and ditches 30 inches deep could be cut without any trouble practically over the entire meadow. The most sand was found on the Falkenburg meadow near the upland, and there sand was found from the very top, but the sand is of such a formation that the hand tools went right through and ditches were cut 26 inches deep. Mr. Falkenburg said that water could never get off that part of the meadow until late in June. Nine ditches were cut through this sandy region, and while the men were working in a foot of water the meadow drained off perfectly dry inside of 48 hours after the work was done, and the interesting part is that not only the meadow drained off dry, but three of the ditches dried down to the bottom. The reason for this good drainage is that after the top crust was cut the water quickly drained into these cuts and the sand 24 inches below is soft and porous so the water that did not drain out into the main ditch soaked into the loose sand on the bottom of the ditches. These ditches while all sandy will stand, and there was no indication of caving in after being cut three weeks. A total of 270,000 feet of ditching was done, many pools were filled with sods. This includes the cleaning of about 30,000 feet of old ditches from two to five feet in width.

The work was finished on October 24th, and was satisfactory to all the owners and, on the other hand, a perfect job was done.

Long Beach Township.

Included in this territory is the stretch extending from Barnegat City Junction to the new inlet, a distance of fourteen miles. At the end of the railroad, extending south on this strip is Beach Haven, which is the most important settlement at that end of the line. To the northward no work has been done from the junction to Barnegat City.

When the work was originally done between the junction and the end of the railroad line some co-operation was obtained with the railroad, and some work was done in the cleaning of culverts and ditches that assisted in the drainage work. For a year or two conditions remained in good shape and some work was done by the railroad each spring and more work was done by the township in the way of keeping the ditches clean. South of the railroad to the new inlet the work was always in the hands of the local authorities, and this is in good condition even at the present time.

Complaint was made during the season of 1910 that the railroad was not keeping up its work, and an inspection made during the season showed that this was true. Report was made to the municipal authorities of Long Beach township and also the railroad company, but without any very satisfactory result.

An inspection was made May 12th, 1911, and conditions were found thoroughly bad. The railroad ditches were found unsatisfactory throughout, the ditches had grown up badly and a mere pretense had been made to clean up in any instance. The result of the failure was that not only was the circulation of water from side to side across the railroad dam impeded, but the circulation of the water in the small ditches to the east of the railroad was inpeded, so that very little improvement over the natural swampy condition could be found. It was noted at once that unless radical relief was given serious danger existed of heavy crops of mosquitoes from these blocked-off places.

The investigation was made at the request of Mr. R. F. Engle, and a report was made to him for the township committee. Some action was taken and a man was put on to clean the ditches in the township outside of Beach Haven. This helped matters somewhat in those cases where the ditches ran directly into the bay, but the railroad refused to co-operate, and of course the ditches east of the railroad right of way were not relieved, justifying

again my decision in the areas further north not to have anything to do with the territory east of the railroad lines.

So far then as conditions extended along the whole territory between Barnegat Junction to Seaside Park while the township authorities were measurably free from the charge of negligence, the railroad authorities were absolutely negligent and are responsible for the heavy crops of mosquitoes that emerged everywhere along the route.

This seems an especially short-sighted piece of business, because of the improvements that have been made along this area north of Peahala and so-called Brant Beach. This is a new improvement, and for nearly a mile has been filled up along the railroad so as to improve breeding conditions and facilitate settlements along the railroad. With only a little assistance from the transportation company a sufficient amount of improvement could have been maintained during the season to have encouraged a much greater expenditure by permanent settlers; but so long as the railroad maintains its policy of doing nothing there will be very little encouragement for investors to put money into the area for the benefit of the line.

The railroad should particularly assist such improvements as that made at Brant Beach, because there the improvements are permanent in character and do away with the possibility of breeding, which continues where only ditching is done.

The conditions in Long Beach township, south of Beach Haven, were found good on the whole, and most of the ponds cut in 1907 are yet in good shape and stocked with killies. Only a little cleaning was needed in the long ditch, which runs from the station to the bay and which was nearly a mile in length. It was thought when this ditch was made four years ago that as it was cut through sand practically all the way it would not stand free from blockages, but it has maintained itself and has required very little attention since it was originally put into good shape. Only a little cleaning and improvement has been found necessary, and on the whole stretch of a mile in length and an area of 500 feet in width only a single breeding pool had been found during the past season.

Borough of Beach Haven.

At the request of Mr. Robert F. Engle, an inspection was made on May 12th, and again August 18th. The first inspection was made to determine what was needed to keep the breeding of mosquitoes down, and a full report was made and sent to Mr. Engle, applying in general to the township and borough. Some little work was done, but not enough, and the ditches did not get the attention that they should have gotton, therefore breeding went on.

Conditions became very bad by the first part of August, and help was again asked from the office to locate the places where the mosquitoes came from. The inspection was made on August 18th, and the southern end of the borough was first taken up to see if there were any danger points near at hand. To my greatest surprise no less than eight places were found right in the borough, sufficient not only to supply Beach Haven, but to sprinkle a part of the township as well.

The borough made a dumping ground out of a pond connected with the bay and into which tide water came fresh every day. To start with, they cut the drainage so as to leave the water in the pond stagnant, then they commenced to dump material in the water which killed all the fish, the water turned black and rotten and the mosquitoes then had free play. It can be well imagined how many *pipiens* may breed in a stagnant pool 25 x 100 feet, and they started breeding there practically as soon as the drainage from tide water was cut off, and a few loads of garbage had been dumped into the water. These little fellows were getting into the hotels and cottages in good numbers, but no attempt was made by municipal authorities to locate the danger points until the first part of August, when the pest became so thick that an appeal was sent to the office, asking that an inspector be sent down and the danger points located.

Besides this large breeding place seven smaller ones were found, three in which *pipiens* breed and four where salt marsh species were breeding. The cause for this breeding was due, in practically every case, to the blocking of the drainage. In some instances it was filling in to drive over or the laying of sewer or water pipes. By laying these pipes right across the ditches and

filling or covering them over, the drainage was stopped wherever such work was done and the ditches were not regarded at all.

A full report was sent to Mr. Engle, giving the exact places where the breeding was going on, and the cause of the same.

Beach Haven, it is safe to say, bred practically all its mosquitoes right within the borough, and this could have all been prevented by a little intelligent supervision. It is just such experiences as this that has contributed largely to my decision to do as little as possible along the shore strip, except on the typical salt marsh.

Fairfield Township.

The work done during the fiscal year ending October 31st, 1910, is reported upon in my report for that year. It includes rather more than half of the marsh area within the limits of the township, and the necessary preliminary steps were taken promptly with the beginning of the new fiscal year, so that there might be no delay in starting work when the new appropriation became available. Advertisements were duly published and when bids were received it was found that Mr. Jesse P. Manahan was the lowest bidder for seven thousand dollars ($7,000), for which sum the contract was awarded to him, and all the required legal preliminaries were observed.

Work was started on November 23d with one machine and twenty men. The weather at that time was just right and the meadow was in good shape. There was no difficulty in cutting, and good straight ditches were put in rapidly, none of them less than 30 inches. The work was started between the Cohansey and Middle Marsh creeks, and along this section there is some very bad meadow from which millions of salt marsh mosquitoes hatched almost every week during favorable weather conditions in the summer.

There was no difficulty in getting outlets for our ditches. The creeks through that territory are all wide and deep and many branches run from these main creeks giving us the best possible opportunity to get off surface water. In fact, so numerous are the streams they are rather a nuisance in getting over the meadow, but it makes it possible in most instances to give our ditches two outlets. In such cases, of course, if one outlet gets blocked the other remains open and the drainage goes on just the same. At

the beginning, work progressed very fast, about 10,000 feet were cut daily, and up to November 30th over 70,000 feet had been cut in good shape. At this time the gang was increased to twenty-six men.

Sufficient work was laid out for the gangs in charge to keep them busy until the early part of December, and another visit to the ground was made December 7th and 8th. The weather by that time had changed; there was a thin shell of ice and a light snow on the surface of the meadow. This, while it dulled the tools to some extent, did not prevent the men from working, as most of the ditches had been staked out before the ground was covered with the snow, and the work could be continued without interruption.

This Cohansey-Middle Marsh creeks section was finished December 10th, and on the 12th of the month the men were taken over to the Tweek and Back creek sections, which are east of where the work had been done during the summer, and this was the only piece of undrained marsh remaining in Fairfield township.

The weather now continued to be rather cold, but did not freeze the meadow at all deeply, nor hard enough to interfere with the action of the spades. The salt water coming up to the surface of the meadow occasionally would soften the icy surface and render the ice rotten and mushy, so as to prevent injury to the spades.

A thorough inspection of the work done was made on December 15th and 16th, and on the 16th additional ditches were staked out, which in turn were completed on the 22d and 23d, when the final area was staked out and finished by December 29th in good shape. In all a total of 280,000 feet of ditches was cut, and a few places that did not drain properly were filled in with sods. There are, however, very few places of that character anywhere on this meadow, which as already stated is unusually well drained naturally by the streams which give good outlets to our ditches.

The only real obstacle to the work in this area was the position taken by some of the marsh owners, who are unfamiliar with the effects of the drainage work and who were afraid of the effect of the ditching on the hay crop. They were not even open to argument in the matter and would not investigate. Had it depended upon their actions in the matter not a ditch could have been placed on the meadow. It was in most cases a brutal reliance upon the terms of the law, and a straight-forward declaration that the

meadows would be drained with or without their consent, and if drained with their consent any wishes that they might have in the matter would be considered, that secured us any measure of co-operation at all. We did make some changes in the original drainage scheme to favor some of the marsh owners, but only where these changes would not interfere with the general effectiveness of the work. It is fair to say that a slow reversal of opinion is going on, and that the value of the work is becoming appreciated.

The entire meadow area in Fairfield township was inspected on April 8th and again on June 6th, and everything was found in the best condition. None of the ditches had been blocked intentionally or otherwise and the sods had not floated during the winter and spring tides, so that on the whole the drainage was clear and in good condition.

It was found that both the U. S. Drainage and Irrigation Company and Jesse P. Manahan had fulfilled that part of their contracts with the State that required an overhauling of the ditches after the winter storms and that whatever injuries might have been caused had been completely mended.

The meadow therefore during the early summer was in a decidedly good condition. Mr. Brehme reports the grass longer at the season of the year last examined than ever before at the same time, and especially so on the ten-acre meadow near Sea Breeze, which was under the water at the time the work was started, and on which no hay had been cut for eight or ten years, owing to the fact that it had been rotted out by the water lying on it continually. Since the drainage a new crop had come up, and that was already twelve inches in length at the time the inspection was made.

It had been intended to keep this meadow under a rather close supervision during the summer, and to make use of it as an object lesson. The patch of marsh land in Fairfield township is about as accessible by road and stream as any portion of the marsh land in Cumberland county, and we wished to show the effect of the drainage work on typical salt marsh in this territory and its vicinity, not only in controlling mosquito breeding but in favoring and improving the growth of meadow grasses. The burden of work imposed upon the office from various sources, and my unfortunate physical breakdown made it impossible to carry out all the plans that had been made. The meadow was not visited

by me during the summer at all. It was not even possible to get Mr. Brehme down there until after the season was over, and his final report comes in under date of November and under a new fiscal year.

REPORT

OF THE

ENTOMOLOGICAL DEPARTMENT

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

THOMAS J. HEADLEE, PH.D.

FOR THE YEAR 1912

UNION HILL, N. J.
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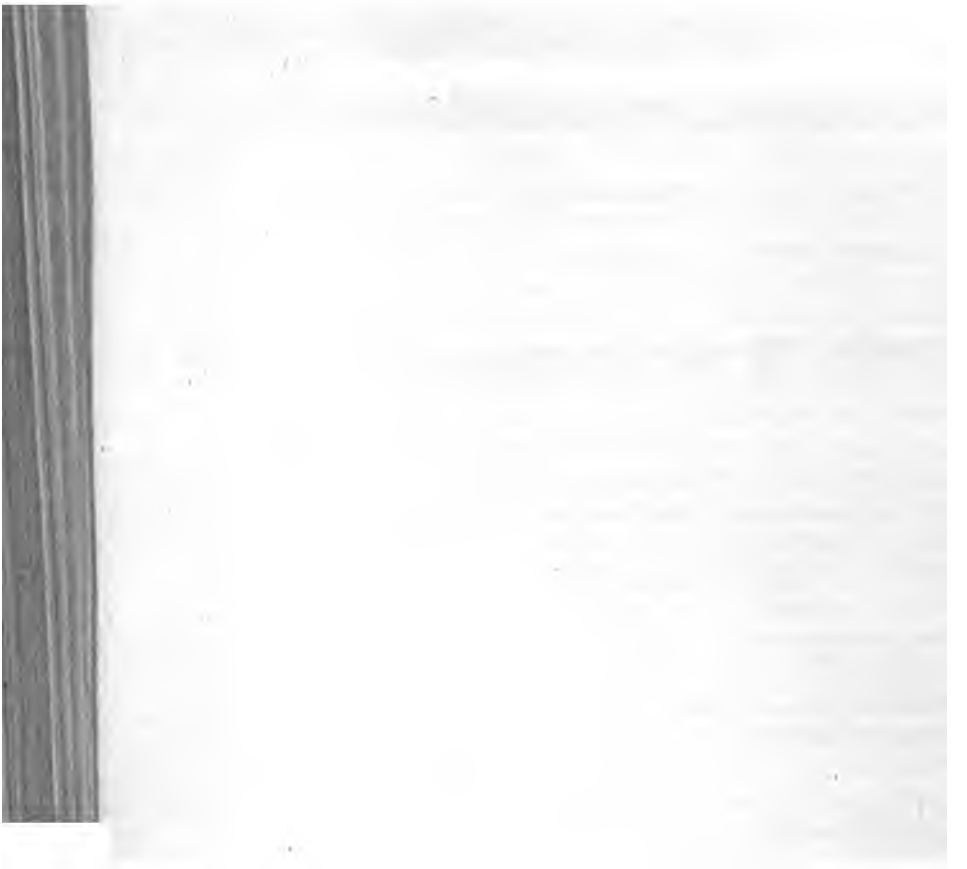


REPORT OF THE ENTOMOLOGIST.

THOMAS J. HEADLEE, *Ph.D.*

During the past year the State of New Jersey, and this station in particular and country at large, have suffered an irreparable loss in the death of Dr. John B. Smith. Dr. Smith was one of a small group of American entomologists whose work as standard bearers has placed American economic entomology in the front rank among the nations. Like most members of this group he was at once a naturalist, a systematist and an economic entomologist.

The illness, which resulted in his death on March 12th, 1912, prevented him from prosecuting any researches during the period covered by this report, and such work as has been carried on was in the immediate charge of his assistants, Mr. Harry B. Weiss, Mr. Herman H. Brehme and Mr. Raymond S. Patterson.

Following the death of Dr. Smith the work of his office was divided, and Mr. Harry B. Weiss was made acting State entomologist, Mr. Herman H. Brehme acting executive officer in charge of the mosquito work, and Mr. Raymond S. Patterson was given charge of the teaching and the continuance of certain lines of experimental work with which he had already been identified, and Miss Augusta Meske charge of the clerical work of the office.

Thus the work of the office was conducted until October 1st, 1912, when the writer took up his duties as Dr. Smith's successor. No other changes in the regular staff occurred during the year.

Most of the matter set forth in this report is drawn from the notes of these assistants, and wherever practicable the facts are stated in their own words with only such changes as are incidental to editing.

THE ENTOMOLOGY BUILDING.

By RAYMOND S. PATTERSON.

On February 1st the department moved into the new building which had been fitted up for it. As the force is now constituted ample room is provided for the work, but there is little space for expansion in the future. The building is located on Neilson Campus in the rear of the New Jersey Experiment Station Building, fronting on Bleecker place. It is approximately 30 by 50 feet with two full stories with attic and basement. The walls are of brick, the partitions of hollow tile, the ceiling of plaster board and the floors of a cement composition, making the building practically fireproof. The plumbing and wiring are exposed and fire extinguishers have been installed to minimize the danger of fire.

On the first floor is a large class room and student laboratory, 26 by 28 feet, provided with ample equipment for the student work. In the rear of this room are two offices, for the chief nursery inspector and temporary quarters for Mr. Agee, the head of the extension work of the station.

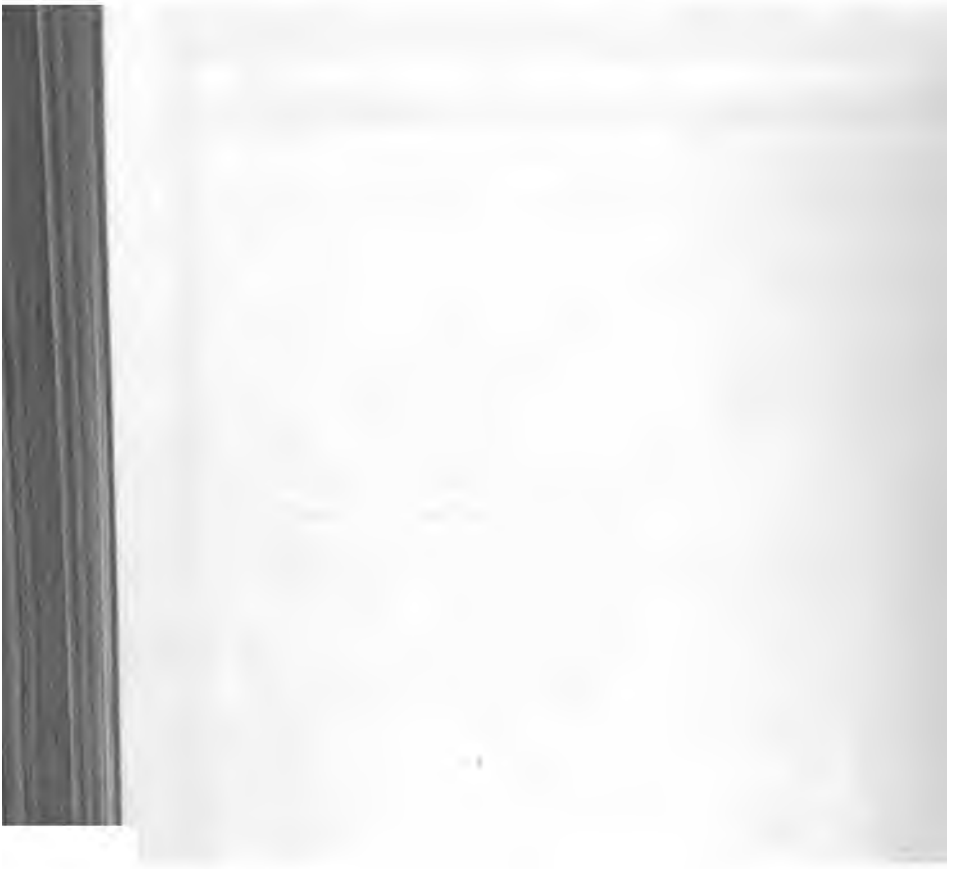
The arrangement of the rooms on the second floor is similar to that of the first, and here the large room is equipped as a laboratory for the work of the State and College Experiment Stations, containing the general insect collections and the John Bernhardt Smith collection of Lepidoptera. The offices of the entomologist and that of the clerk are well lighted and appropriate to the needs.

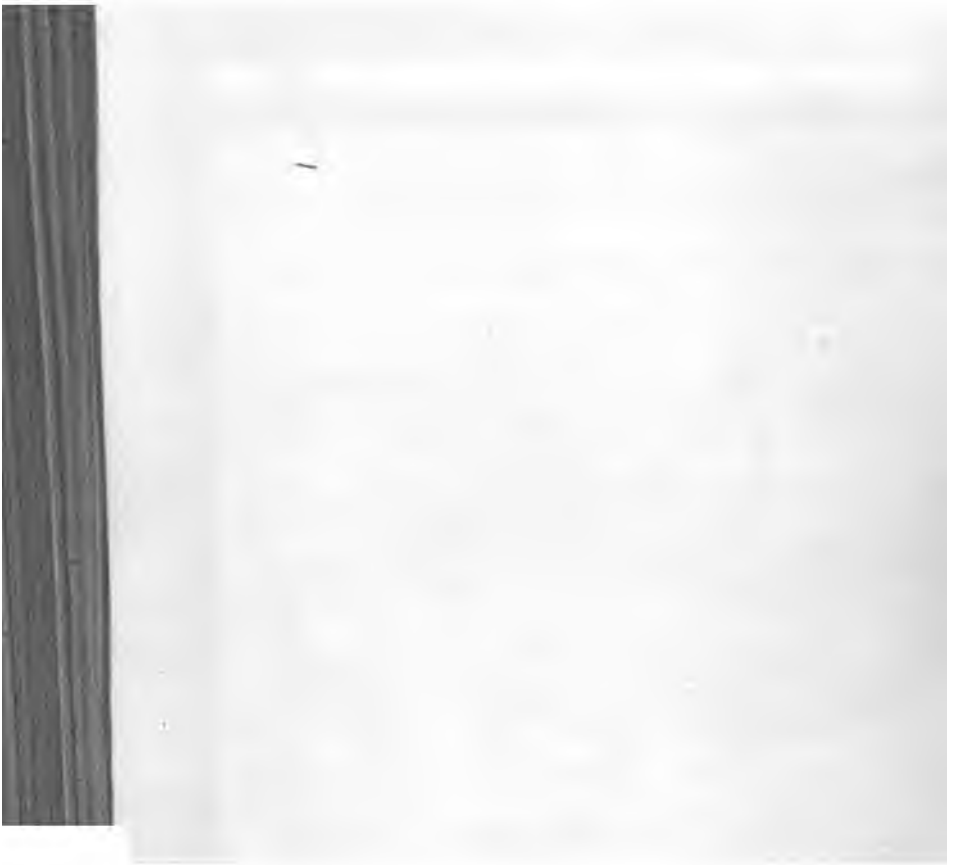
A well equipped dark room has been provided for the photographic work of the department, and in the attic there is ample room for all necessary storage.

The insect record presented in Mr. Weiss' notes is only relatively complete, for nothing other than the most definite information is included.

PLATE I.

The Entomology Building.





INSECT RECORD.

By HARRY B. WEISS.

Shade Tree Insects—Elm Leaf Beetle.

Galerucella luteola Mull.

During the season of 1912 the elms, taken as a whole throughout the State, suffered considerably less from the elm leaf beetle than the previous year.

All stages of the beetle were hard to find on the campus elms, and it is doubtful if they really needed the spraying which they received.

In Bound Brook, Plainfield and Somerville only isolated trees suffered to any great extent, and this is true of other northern New Jersey cities. Trees that received sprayings for the past few years looked exceptionally well during the entire summer.

The elms of Elizabeth looked poorer than any others in the State, and showed signs of considerable feeding.

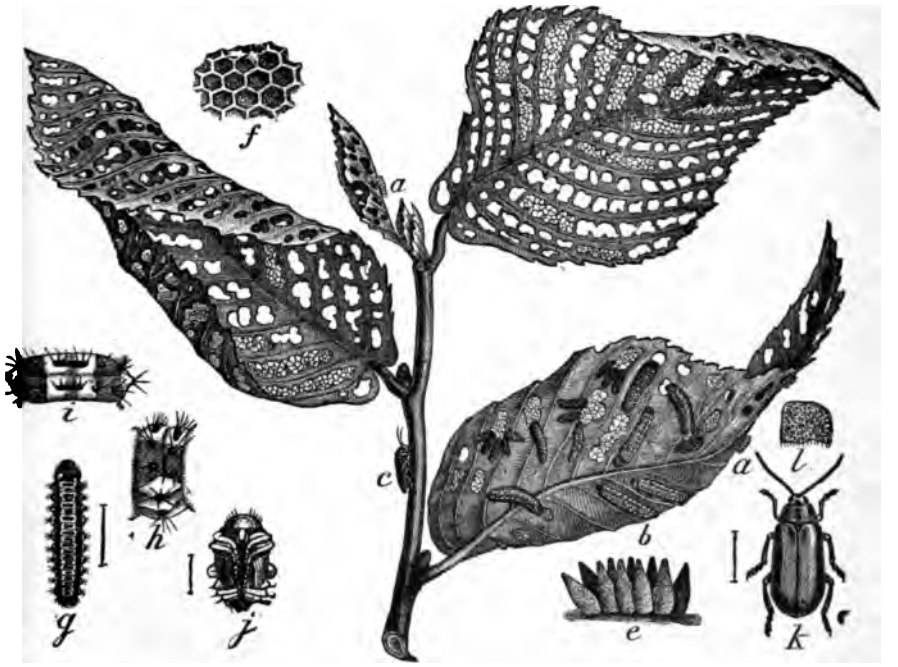


Fig. 1.

Elm-leaf beetle: *a*, *a*, egg-patches on leaves; *b*, larvæ feeding; *c*, adult; all natural size: *e*, egg mass; *f*, surface of egg; *g*, larva; *h*, *i*, details; *j*, pupa; *k*, beetle, and *l*, its elytra; enlarged. From Div. Ent., U. S. Dept. Agric.

The first beetles were observed by Mr. R. S. Patterson on May 13th, and egg laying started soon afterward. By July 18th it was possible to find many full grown larvæ and pupæ, and even a few new adults were observed.

According to Mr. Patterson, the elms in the vicinity of Springfield looked poor and showed considerable feeding in patches. He attributes their poor appearance more to last year's ravages than to this year's feeding. At Millburn and Maplewood, the trees looked considerably better, and in Newark were practically free from injury. This result has no doubt been obtained by the careful and excellent work of the Newark Shade Tree Commission.

The few elms in South Jersey were, with few exceptions, injured only slightly. The isolated trees in the State which showed considerable feeding, were for the most part in outlying sections of the cities and along the country roads. These trees made it possible for the hibernating brood to become quite large.

Hickory Bark Beetle.

Scolytus quadrispinosus Say.

This is one of the regularly complained of insects, and never a summer passes without having owners of hickories appeal to the office for help. The wilting of the foliage due to the beetles burrowing in the leaf petioles and twigs usually attracts more attention from the average person than the work of the beetles in the bark.

These troublesome little fellows, which are about one-fifth of an inch long, and brown or black, appear during the last of June and attack the growing twigs and terminal buds, causing a wilting of the foliage. It is supposed that this is done for the purpose of obtaining food.

Later, they attack the trunk and large branches, cutting their burrows and galleries in the bark and completely girdling the trunk or limb, if numerous.

Small circular holes in the bark are indications of this pest's work. If a tree is slightly infested, its life may be prolonged a few years by stimulation with fertilizers. Considerable protection undoubtedly can also be gained by spraying the trees about the

last of May with arsenate of lead at the rate of eight or ten pounds to fifty gallons of water. This should poison the beetles when they eat into the twigs and leaf petioles. If a tree is badly infested it had better be destroyed, as only in this way is it possible to protect adjoining uninfested trees.

The Cottony Maple Scale.

Pulvinaria innumerabilis Rathv.

During the past season this insect easily took first rank among the shade tree pests complained of. It was abundant in practically all parts of the State, and especially so in the east. The maples in Rahway, which city undoubtedly suffered the most, looked a sickly yellow by the first week of July and many branches were partly dead.

It can be said that the maples in the State underwent a pruning process as the result of this insect's abundance. No permanent damage was done, however, and next year its natural enemies will undoubtedly have regained control.

Fig. 2.

Cottony maple scale, *Pulvinaria innumerabilis:* showing at *a*, the female on a leaf, and at *b*, same on a twig.
N. J. Ag. Exp. Sta.

One objectionable feature—aside from its destructiveness to small limbs—was the enormous amounts of honey dew given off. This sticky material covered everything beneath the trees and made it impossible for many householders to enjoy the shade which the trees afforded.

In ordinary seasons cutting off and destroying in June all branches infested with the cottony masses is all that is necessary. During a season like the past, it is well to spray badly infested trees with one pound of whale-oil soap to four gallons of water, making the applications when the young are crawling.

The Tulip Soft Scale.

Eulecanium tulipiferæ Cook.

The tulip soft scale was a close second in numbers to the cottony maple scale, and many specimens from different parts of the State were sent to the office for identification. As a rule, remedial measures are rarely necessary. Whale-oil soap, one pound to four gallons of water, will kill the young, but this application is practical only on small trees.

Most of the damage the past summer was confined to small trees and consisted of a killing of the smaller branches. As was the case with the cottony maple scale, no permanent damage resulted and its most objectionable feature was the production of large quantities of sticky honey dew.

This scale occurs only on tulip trees and can be easily recognized by its livid gray color and its large size, being somewhat hemispherical and almost one-quarter of an inch in diameter.

Oak Pruners.

Elaphidion sp.

Oak pruners were quite persistent this season in forcing their unwelcome attentions upon owners of oaks and hickories.

If one finds the ground under his favorite oak strewn with twigs and small branches, severed as if with a knife, it is fairly certain

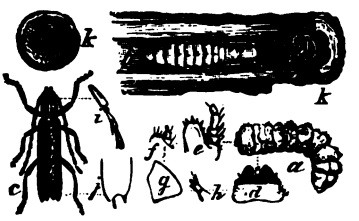


Fig. 3.
The oak pruner, *Elaphidion parallelum*: *a*, larva; *b*, pupa in its burrow; *c*, beetle; *k*, *k*, cut ends of the twig; *d* to *i*, structural details. From U. S. Div. of Ent.

that oak pruners are at work. On account of their method of feeding they enjoy almost perfect immunity from natural enemies.

By securing the co-operation of neighbors in gathering and burning from time to time these fallen twigs which contain the larvæ, it is possible to control this insect and lessen to a considerable extent the injury for the following year.

Oak Web Worm.

Archips fervidana Clem.

During the second week in June this species attracted some attention at Towacon, where it webbed up entire scrub trees and bushes. But nowhere else did it become numerous enough to attract attention.

White-Marked Tussock Moth.

Hemerocampa leucostigma S. & A.

From Trenton southward along the Delaware river, in all the larger towns and cities, this was the most common pest of shade trees and took its usual amount of toll.

The Maple False Scale.

Pseudococcus aceris.

According to our own observations the Maple false-scale was not much in evidence, and only one specimen was sent to the office.

Hickory Gall Aphid.

Phylloxera caryæ-caulis Fitch.

These characteristic galls on the twigs and leaf petioles of hickories in northern New Jersey were plentiful this season, and many owners of individual trees feared something serious.

They are always more or less common and other than the deformation of the twigs, no harm is ever done.

Bag Worm.

Thydridopteryx ephemeræformis Steph.

While not especially abundant during the past summer, this insect attracted some attention in the southern part of the State. Not a single complaint was recorded north of Trenton.

It was noted in many South Jersey towns on deciduous shade trees and in Moorestown, Riverton and Haddon Heights it became locally injurious.

During the winter the gray silken bags containing eggs are plainly visible on the leafless trees and may be picked off and de-

stroyed. If this is not feasible, the trees can be sprayed with arsenate of lead, while the eggs are hatching, which is some time during May. The exact time can readily be determined by keeping a few of the sacs under observation during this month.

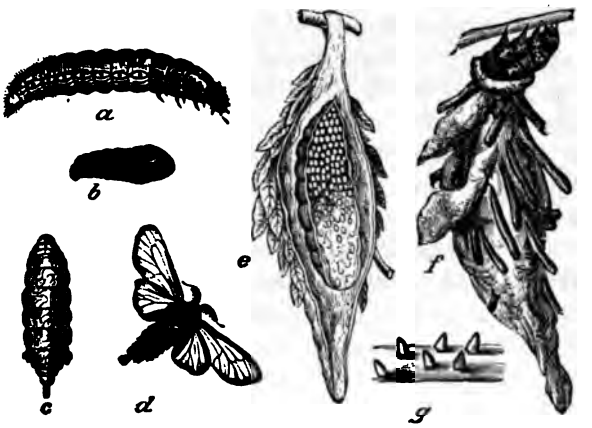


Fig. 4.

The bag worm, *Thyridopteryx ephemeraeformis*: *a*, larva; *b*, male pupa; *c*, female: *d*, male moth; *e*, bag of female cut open to show the mass of eggs; *f*, caterpillar with bag in normal position; *g*, young larvæ with bags carried upright.
From U. S. Div. Ent.

Forest Insects—Yellow Striped Oak Caterpillar.

Anisota senataria Sm. & Abb.

As a forest insect this was probably the most important species of the season. During the first week in September Mr. Alfred Gaskill, State Forester, reported areas of an acre or more in the vicinity of Brown's Mills, Burlington county, on which the oaks were as bare as in mid-winter, and similar injuries were observed by him in portions of Sussex county. An office correspondent from Vail, Warren county, also referred to considerable injury in that section, and undoubtedly there were other places of which this office did not hear. The caterpillars, which are black with orange yellow stripes and prominent black spines, have the habit of feeding side by side in large masses.

By the second and third week in September the majority,

which are full grown and about two inches long, have entered the ground for pupation.

According to Dr. E. P. Felt the moth is of a bright reddish color, front wings specked with black dots and large white spots near the middle, and appears about the second week of June, laying 200 to 300 eggs in a single cluster on the underside of the leaf, the eggs hatching in a week or ten days.

According to the late Dr. John B. Smith, no permanent injury is caused, as its natural enemies usually control it.

Most of the injury was, of course, done to the scrub oak, *Quercus pumila*, but Mr. Gaskill observed the caterpillars feeding just as voraciously on Scarlet Oak, *Quercus coccinea;* Black Oak, *Quercus velutina;* Red Oak, *Quercus rubra;* Post Oak, *Quercus minor;* White Oak, *Quercus alba;* Chestnut Oak, *Quercus prinus.*

Birch Leaf Skeletonizer.

Bucculatrix canadensisella Cham.

While making nursery inspections in portions of Morris county, during the first week in September, quite a lot of injury by this insect was noted on white birch, *Betula papulifolia.*

The larvæ, which are yellowish green and about one-quarter of an inch long when full grown, can be found feeding on the leaves during August or early September. A curious feature in connection with this insect is the moulting cocoon which the larva makes. These are flat, circular, about one-twelfth of an inch in diameter and scattered all over the leaves. The true cocoons in which the winter is passed are elongated, dirty yellow, ribbed affairs about one-fifth of an inch long, which are spun during the latter part of September. While the birches are of not much value commercially, yet the insect deserves a passing mention. Heretofore it has been recorded only from Essex county.

Pine Saw Fly.

Lophyrus abbottii Leach.

According to "Insects of New Jersey" the pine saw fly is locally and seasonally common on pines throughout the State. During the past spring Mr. Gaskill, State Forester, reported it to be locally injurious to pines at Lakehurst, Ocean county, Pemberton, Burlington county, and Allamuchy, Warren county, and it has off and on been the subject of inquiry from owners of large estates.

The adults are rather stout four-winged insects and are called saw flies on account of the saw-like ovipositor at the tip of the female's abdomen. The eggs are deposited in little slits in the leaves and hatch into the caterpillars which do the destructive work. When full grown these are about one inch long, with a black head and yellowish white body marked with two rows of black dots down the back. When ready to transform they spin brownish cocoons at the base of the tree among the leaves. According to Dr. Riley, some of the flies issue early in the spring and others during the latter part of June. There appears to be one generation annually, and young pines are likely to suffer the most.

Inasmuch as the larvæ feed only on the leaves, they are capable of being poisoned and injury can be avoided by spraying the infested trees with arsenate of lead, one pound to twenty-five gallons of water.

Fruit Insects—San Jose Scale.

Aspidiotus perniciosus Comst.

Many orchardists in the State complained of a slight gain made by this insect during the past season. From observations made by this office the scale did increase somewhat toward the end of the season, but this pest is so well known and so easily controlled that there is no occasion for alarm or no excuse for allowing it to regain the upper hand.

Oyster Shell Scale.

Lepidosaphis ulmi Linn.

During the past season this scale has been responsible for the poor condition and death of quite a few shade trees in South Jersey. Maples seem to suffer the most, and it is in small towns and cities that one finds it most abundant. As a rule, badly infested single trees are found instead of a number of slightly or moderately infested ones. On the whole, this scale attracted considerably more attention than the San José.

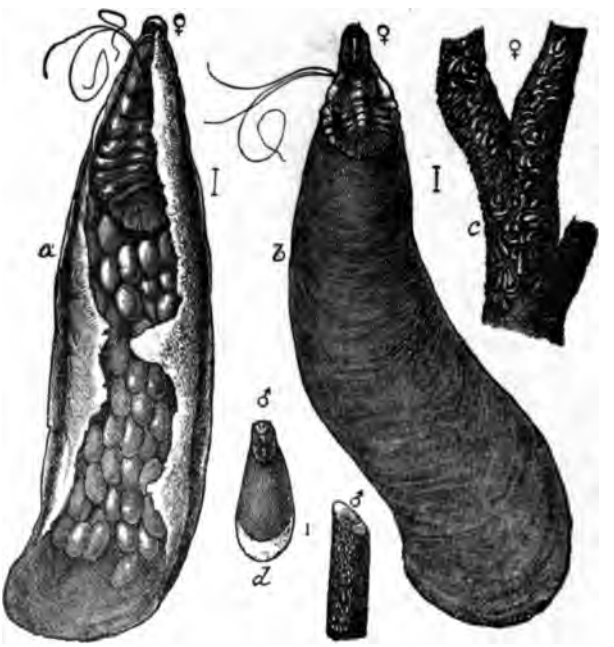


Fig. 5.

Oyster shell scale, *Lepidosaphis ulmi*: *a*, female scale from beneath filled with eggs; *b*, same, from above; *c*, twig infested by female scales; *d*, male scale and a twig infested therewith. From Div. Ent., U. S. Dept. Agric.

Pear Midge.

Contarinia pyrivora Riley.

On the College Farm Mr. Blake reports that practically all of the Lawrence pears were infested and worthless. This was the only place in the State from which the work of the pear midge was brought to the notice of this office. During previous years it has been reported from Essex and Union counties.

Fruit Bark Beetle.

Scolytus rugulosus Ratz.

Peach growers, who are not always careful concerning orchard practice, are always likely to find their trees infested by bark beetles, and many instances of the work of these insects were observed in neglected orchards.

Codling Moth.

Carpocapsa pomonella Linn.

The apple crop in New Jersey was light this year and suffered considerably from the second brood of codling moths, which was larger than usual.

As a rule, the spraying against the first brood is all that is necessary in this State.

As Dr. Smith has always said, it will pay the apple grower south of the red shale line to band the trees to attract the larvæ in July and to kill them at intervals of a week.

Strawberry Weevil.

Anthonomus signatus Say.

Strawberries in various parts of Cumberland county were attacked by this weevil. In fact, scarcely a season passes without a complaint from this section. In the vicinity of Vineland several commercial growers have practically been put out of business by the ravages of this insect.

Fig. 6.

Work of Strawberry Weevil: *a*, spray with punctured buds; *b*, wilting buds; *c*, egg; *d*, larva; *f*, pupa—all three enlarged; *g*, flower with feeding punctures. From U. S. Dept. Agric.

Nothing new has been discovered in the way of controlling it, and the only hope at present seems to be in having the bulk of the crop consist of a good pistillate variety, which is not subject to weevil attacks; with the remainder, a profusely flowering staminate variety, planning, of course, to sacrifice this to the beetle, as long as enough pollen is produced to fertilize the bulk of the plants.

Apple Leaf-Hopper.

Empoasca mali Le B.

Although apple leaf-hoppers occur throughout the State they were seriously numerous in one orchard only—in Middlesex county; in fact, this particular orchard has for the past few years suffered more or less from such attacks.

This year the owner sprayed about the second week in May, when many nymphs were present, with Black Leaf 40, one pint to every 100 gallons of Pyrox, and also with Black Leaf 40, one pint whale-oil soap, five pounds, and 100 gallons of Pyrox. The former did good work and the latter somewhat better.

Black Leaf 40 alone at the rates of one-half and one pint to fifty gallons of water did effective work in killing nymphs, but the adults fly readily and are harder to kill.

Good results are to be obtained if the pressure is high and a fine spray directed below and to the sides of the tree. This will kill the adults while in flight and the slower moving nymphs.

Nursery Insects—Red Spider.

Tetranychus bimaculatus Haw.

As nursery pests, these creatures, which are not insects, but mites, caused considerable injury to evergreens during the summer. Practically every nurseryman in the State had words of condemnation for the red spider. The extremely dry weather was very favorable for their development and they became numerous enough in some places to discolor the foliage completely. As a rule, their presence was not noted until the discoloration was well under way.

The mites, which are scarcely visible to the naked eye, spin a web over the foliage of evergreens and on the undersides of the leaves of deciduous trees, until a complete network is formed, such net being visible only through a glass. Here may be found eggs and individuals in all stages of growth busily engaged in extract-

ing sap from the tissues. Not only did evergreens suffer, but also many deciduous trees in practically all parts of the State.

Red spiders are susceptible to the various contact insecticides such as whale-oil soaps, tobacco preparations and extracts, and dilute lime and sulphur was used with some success during the past summer. The materials should be applied thoroughly and with sufficient force, so that all parts of the plants receive a wetting.

Cottonwood Leaf-Beetle.

Melasoma scripta Fab.

Contrasting sharply with conditions last year, the cottonwood leaf-beetle was nowhere present in the nurseries in sufficient numbers to warrant the application of sprays. To be sure, it was present and did some feeding, but only a minimum amount.

Yellow-Necked Caterpillars.

Datana sp.

These larvæ of Datana species were plentiful on apple in some of the nurseries, but did comparatively little damage. As an orchard pest they attracted no attention whatever.

Pine Leaf Scale.

Chionaspis pinifoliæ Fitch.

Practically all the requests for identifications of this insect came from nurserymen, inasmuch as probable customers are quick to detect the whitened appearance of the needles when the infestation is bad.

Fig. 7.
Section of needles infested with the Pine Leaf scale.

Young trees in particular, when infested, are weakened and not at all attractive and consequently unsalable.

The winter is passed in the egg stage, the eggs hatching during May. A miscible oil at the rate of one part to forty parts of water, applied when the young are crawling, will be found effective.

Wood Leopard Moth.

Zeuzera pyrina Fab.

In making nursery inspections in northern New Jersey the work of this insect was noted in a considerable number of instances in shade trees and shrubs. One larva working in a main stem or trunk is sufficient to spoil a young tree, and nurserymen should not hesitate to destroy infested trees immediately.

Beneficial Insects—Wheel Bug.

Prinonidus sp.

This attractive specimen always receives considerable attention from information seeking persons, and is practically the only beneficial insect sent to the office. The adult, which is brown in color, receives its name from the toothed semicircular crest on its thorax. It is one of our beneficial forms and feeds on all sorts of other insects, attacking them with its powerful beak and sucking their juices. The eggs, which resemble little jugs, are always laid in hexagonal masses, on tree trunks, fences and the like, and are easily recognized. It goes without saying that such friends of the farmer should be preserved.

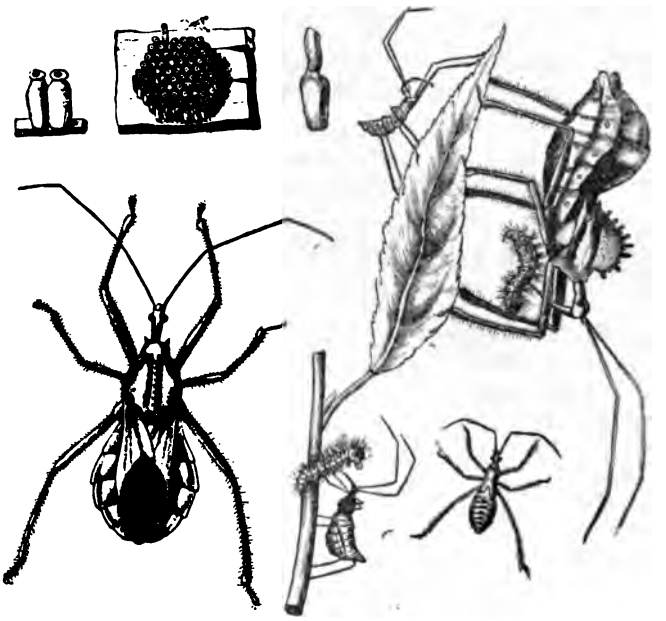


Fig. 8.

The Wheel-bug, *Prionidus cristatus*, in all its stages: natural size.
N. J. Ag. Exp. Sta.

General Crop Pests—Plant Lice.

The growing season of 1912 began a week or so later than usual and with cool, wet weather and, as could be expected, plant lice of all species were abundant during May and June. Apple, grape, cherry and small fruits were the chief sufferers early in the season, and along toward the first of July potatoes were attacked. From the curling and twisting of the tips of apple and cherry trees, it looked very much in the beginning as if serious damage might result, but favorable weather, lady birds and parasitic enemies quickly put an end to the lice.

Inasmuch as potatoes are not commonly attacked by plant lice, any injury to this crop usually stirs the growers to quick action. Consequently much alarm was felt by several large growers in the vicinity of Bordentown when an outbreak occurred there.

Almost invariably when an attack like this occurs and it seems as if the crop were doomed to destruction, bacterial diseases and unfavorable weather conditions arise and carry off millions of the lice, making the application of insecticides unnecessary time and time again.

In case one does not care to wait and see this happen and few persons do, when it is their crop that is threatened, the following spray will be found effective: One ounce of Black Leaf 40 to eight gallons of water; to every ten gallons of this add one pound of "Fels Naptha Soap."

This can be applied to either potatoes or tomatoes infested by plant lice.

Care should be taken to apply it in a fine forcible spray, as it is only in this condition that it exerts its maximum insecticidal value. More failures in spraying for plant lice are due to careless application than to any other cause.

Cut Worms.

Noctuid Species.

Early in the season cut worms occurred in unusual numbers in practically all parts of the State, and caused considerable injury to early truck crops.

Cut worms, which are the larvæ of owlet moths, hide during the day and emerge at night with an appetite for anything that is green and succulent. Their presence is easily detected by finding young plants cut off close to the ground.

Poisoned baits, which are the most widely used and satisfactory remedies, may consist either of poisoned vegetation or poisoned bran. The vegetation may be clover, which has been sprayed with Paris green, cut off close to the ground and placed while fresh in little heaps around the infested plants.

The poisoned bran, which is probably the most efficient, is made by mixing three ounces of molasses with a gallon of water, adding about a pound of bran and stirring in Paris green or some other arsenical poison. Little heaps of this are placed around infested plants.

Whatever bait is used should be applied as soon as a cut worm attack is noticed, as only in this manner is it possible to secure anything like adequate protection.

Rose Chafer.

Macrodactylus subspinosus Fab.

These were troublesome locally, both in north and south Jersey, more so, however, in the south. No serious complaints were received. In some parts of the peach sections they fed ravenously on the fruit, as many as a quart being taken just from a few trees.

Common Stalk Borer.

Papaipema nitela Gn.

Corn in the State suffered spasmodically from borer attacks, and in every case the common stalk borer was at fault. A wilting of the young corn, followed by a breaking down and death of the tops, and the presence of a small round hole in the side of the stalk, plugged with larval excrement, are evidences of this insect's work.

Besides corn, tomato, potato, eggplant, spinach and various

flowering plants are likely to be entered, and such weeds as burdock, cocklebur, ragweed and the like are always more or less infested.

The color of the larva varies considerably during its existence, and this is often confusing, many persons thinking that more than one species is present. The color varies from purplish brown to whitish brown and each larva is marked with five white longitudinal stripes which are barely discernible when it is full grown. All of the stripes except the middle one are absent on the first four abdominal segments, thus giving the larva an unusual appearance.

If the stem of the infested plant is large, it will suffice for the entire existence of a larva, but if small several are entered. One brood a year is recorded and, as a rule, the caterpillars which become more than half grown by the end of June, leave the weeds and grass, and enter corn and thicker stemmed plants. This accounts for the fact that outer rows of corn are the ones to suffer.

The full grown larvæ, which are about one and one-half inches long, pupate in the larval burrows and the fawn colored moths or parents issue in September and October and lay eggs on the stems of various plants.

Coming to methods of control, fall ploughing and raking up and burning all vegetation, especially weeds, will be found extremely helpful, or fields can be burned over late to destroy the eggs. Crop rotation is advisable, using onions, cabbages and the like as alternates. It is, of course, impossible to poison the larvæ after they are once in the corn.

Squash Borer.

Melittia satriniformis Hbn.

Squashes in different sections of the State suffered more or less from the attacks of these insects. The moths, with their clear wings and brightly-marked bodies, are frequently mistaken for wasps and appear soon after squash and pumpkins start growth. Oval, dull red eggs are deposited singly, chiefly on the stems, near the ground, or if the soil be light, slightly below. These hatch in a week or two and the larvæ enter the main stem, boring through,

causing it to decay, wilt and die. After becoming full grown, which usually takes a month, they enter the ground and construct their cocoons just below the surface, in which they remain until the following spring, when they transform to pupæ, and then to adults. A partial second brood has been observed in New Jersey.

Owing to their concealed methods of feeding, it is obviously impossible to poison the larvæ.

After a vine is once infested, they may be cut out, where the wilting vine denotes their presence. All cuts should be made longitudinally, and afterward rubbed with soil, or poor results are likely to occur.

Where squash growing is an important industry, a trap crop of some summer variety should be planted. As it happens, these often do well even when infested, and by the time the main crop, which should be planted later, is well established, all the eggs will have been laid. The early variety, if for trap purposes only, should be taken out and burned, and if the crop is allowed to mature, all vines should be raked together immediately afterward and burned.

In all cases clean farm practice is desirable and crop rotation will help materially to decrease the number of moths.

White Grubs.

Lachnosterna spp.

Many persons will remember the past summer for its white grubs, if for nothing else, and it could be aptly termed "the white grub summer." These insects, which are the larvæ of May and June "Bugs," easily surpassed themselves in their efforts to cause trouble. Not only did complaints come from persons engaged in agricultural pursuits, but from city parks and owners of golf links and lawns. In fact, these latter places were damaged the most, and to make matters worse, toward the end of the season, the crows in many places tore up the sod in their efforts to procure these toothsome morsels.

Of course land which has been in sod for three years is bound to be infested, and the crop which follows is bound to suffer.

Unfortunately, no satisfactory insecticides for underground insects have yet been brought forth. For the agriculturist, keeping fields in grass as short a time as possible is best. If old sod must be used, it should be ploughed up in early or middle September, which operation will expose the pupæ and tender beetles. The younger grubs still in the ground can be reached by turning in hogs. They will do the rest.

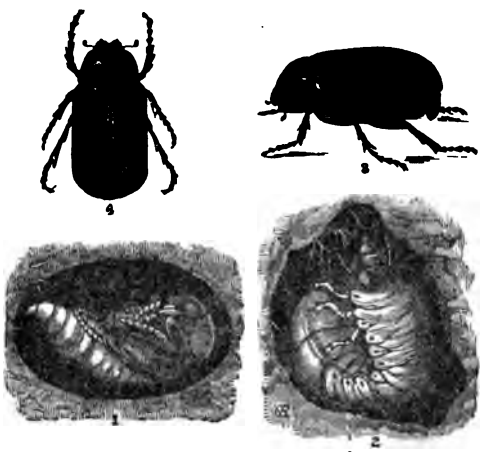


Fig. 9.

May-beetle and white grubs: 1, the pupa in its cell; 2, larva or white grub, feeding; 3, 4, the beetles. After Riley.

After they are once present in strawberry beds, and these were somewhat troubled during the past summer, the most satisfactory method is to dig the grubs out.

Eradicating them from golf courses and lawns is a more difficult matter, inasmuch as in these places, which are natural breeding grounds, they are strongly intrenched.

Ploughing up a golf course and turning in hogs would practically put the devotees of the game out of business, and most people would object to pasturing these animals on the lawn.

Mr. G. W. Herrick, of the Cornell Station, suggests the liberal application of a 10 per cent. solution of kerosene emulsion to infested lawns, followed by copious watering for two or three days to carry the oil down and bring it into contact with the grubs.

Some experimental work on the effects of certain insecticides was prosecuted by Mr. Weiss and his statement of results follows.

INSECTICIDES.

By Harry B. Weiss.

Preliminary Report on Greenhouse Insecticides.

In large establishments the different houses are in charge of men who are supposed to know not only everything concerning the plants in their charge, but also everything about the insects infesting or likely to infest them and their control. As a result, ideas run rampant, as to amounts, methods and times of application, and a few insecticides cover, or are supposed to cover, a wide range of insects. In many cases, applications are made according to "rule o' thumb," no one knowing the definite amounts of materials used. Time also is an important factor, insecticides being applied only when there is time, regardless of immediate needs. As to apparatus, most of it is out of date and sees more service in shading the houses than anything else.

The most popular insecticides are sulphur, tobacco extracts, tobacco dusts and various soaps, and these seem to be used without due regard for their special purposes. For instance, the tobacco extracts might be used against the various scale insects—and as a matter of fact are. Moreover, powdered tobacco is used again and again without a knowledge of its composition. Soaps often vary in composition, and after using apparently the same materials, one obtains widely different results.

As to effectiveness in general, one finds that a personal element enters into this. Most men have a pet material, which they firmly believe in and for which they make all sorts of claims. In some cases, the worse it smelled the better work it did. No accurate observations are made, and in most cases the statements of these men are absolutely unreliable.

Much useless spraying is practiced, entire houses receiving an application of one material, when such houses contain a variety of plants infested by armored and unarmored scales, mealy bugs and red spiders.

The most effective work is done when houses are overhauled and plants repotted. At this time badly infested plants are destroyed, infested leaves are pulled off, and on valuable plants the tooth brush is put into operation. When insects are present only in

small numbers they are sold with the plant. In some places hardly an order leaves the establishment before it is gone over with tooth brushes and pointed sticks, the latter instruments being used for removing adult lecaniums.

The changing population of some houses by selling and replenishing often aids the nurseryman considerably, as in this way an infestation has not the chance to become serious.

Quite an interchange of insects is carried on in buying and selling greenhouse stock, there being of course no regular inspections on the part of the buyer. If a slight infestation is present, it is taken as a matter of course and hardly noticed. If it is bad, the usual complaint is made, followed by an exchange of letters, with the result that the buyer pays less for the stock than he had intended. The fact that the insects are introduced and will gain a foothold in the greenhouse seems to be entirely overlooked.

In order to determine the value of some of the various preparations sold as greenhouse insecticides, palms infested chiefly by *Chrysomphalus dictyospermi* Morgan were treated according to the following table. *Kentia forsteriana, K. Belmoreana, Latania rubra* and *Pandanus Pacificus* were all infested by *Chrysomphalus dictyospermi* Morgan and *Pandanus Veitchii* by *Chrysomphalus aonidum* Linn. Of course, not all of the materials mentioned in the table are recommended for greenhouse use.

PLANT.	MATERIAL.	STRENGTH USED.	EFFECT ON PLANT.	EFFECT ON ADULT SCALES.
Kentia forsteriana	Ivory soap	1 lb. to 4 gals. water—applied warm	None	None.
" "	" "	1 lb. to 4 gals. water—applied cold	None	None.
" "	Fels Naptha soap	1 lb. to 4 gals.—applied warm	None	None.
" "	" " "	1 lb. to 4 gals.—applied cold	None	None.
" "	Lemon oil	1 to 20	None	None.
" "	Commercial Kerosene emulsion	1 to 30	None	None.
" "	Tobacco soap	2 oz. to 1 gal	None	None.
" "	Tobacco soap, ½ lb. sulphur	2 lbs. to 12 gals., ½ lb.—boiled 15 min	None	None.
" "	Fir Tree Oil soap	1 oz. to 1 gal	None	None.
" "	" " "	2 oz. to 1 gal	None	None.
" "	Nikateen	4 teaspoons to 1 gal	None	None.
" "	Goods Caustic Potash Whale Oil soap No. 3	2 oz. to 1 gal	None	None.
" "	" " " " " " "	1 oz. to 1 gal	None	None.
" "	" " " " " " "	4 oz. to 1 gal	None	None.
" "	Scalecide	1 to 40	None	None.
" "	"	1 to 20	None	All dead.
" "	"	1 to 10	Slightly burned	All dead.
Pandanus Pacificus	"	1 to 10	None	All dead.
Kenti forsteriana — Kentia Belmoreana	"	1 to 8	Slightly burned	All dead.
Pandanus Veitchii	"	1 to 8	Badly burned	All dead.
Livistonia rotundifolia	"	1 to 10	None	All dead.
K. forsteriana—K. Belmoreana	"	Undiluted	Badly burned	All dead.
K. Belmoreana	"	1 to 5	Slightly burned	All dead.
K. Belmoreana Pandanus Veitchii	Black Leaf 40	3 qts. to 50 gals	None	None.
Pandanus Veitchii	" " "	6 qts. to 50 gals	None	None.
Pandanus Veitchii	Flowers of Sulphur	Applied by bellows	None	None.
Pandanus Veitchii—Ficus altissima	Kerosene emulsion, home made	1 to 3	Slightly burned	All dead.
Kentia forsteriana	" " " "	1 to 3	Slightly burned	All dead.
Livistonia rotundifolia	" " " "	1 to 3	None	All dead.
Kentia Belmoreana	" " " "	1 to 3	Slightly burned	All dead.
K. Belmoreana—K. forsteriana	" " " "	1 to 6	Slightly burned	All dead.
K. forsteriana	" " " "	1 to 5	Slightly burned	All dead.
Pandanus Veitchii	Scalecide	1 to 20	Slightly burned	All dead.
" Pacificus	"	1 to 20	Slightly burned	All dead.
Livistonia rotundifolia	"	1 to 20	None	All dead.
Ficus altissima	"	1 to 20	One leaf burned	All dead.
Latania rubra	"	1 to 20	Slightly burned	All dead.
Areca Verschafeltii	"	1 to 20	None	All dead.
K. forsteriana—K. Belmoreana	"	1 to 30	None	80% dead.

PLANT.	MATERIAL.	STRENGTH USED.	EFFECT ON PLANT.	EFFECT ON ADULT SCALES.
K. forsteriana	Scalecide	1 to 30	Slightly burned	75% dead.
K. forsteriana—K. Belmoreana	Target Brand	1 to 10	None	All dead.
K. Belmoreana—K. forsteriana	" "	1 to 20	Slightly burned	All dead.
K. forsteriana	" "	1 to 30	Slightly burned	All dead.
K. forsteriana	H. C. N.—30 min.	1 oz. to 100 cu. ft.	All dead	All dead.
K. forsteriana	" " " " "	½ oz. " "	Badly burned	All dead.
K. forsteriana	" " " " "	¼ oz. " "	Burned	All dead.
Pandanus Pacificus—Livistonia rotundifolia—				
Pandanus Veitchii	" " " " "	¼ oz. " "	None	All dead.
K. forsteriana	" " " " "	⅛ oz. " "	Burned	All dead.
K. Belmoreana—K. forsteriana	" " " " "	1-16 oz. " "	None	80% dead.
Kentia forsteriana	" " " " "	3-32 oz. " "	Slightly burned	All dead.
" "	Nico-Fume	1 to 300	Slightly burned	None.
" "	Antipest	1 to 12	Slightly burned	All dead.
" "	"	1 to 16	None	None.
" "	Sherwin-Williams Lime and Sulphur	1 to 15	Slightly burned	None.
" "	Aphine	1 to 12	Slightly burned	None.
" "	Cooper's Summer Tree Spray	1 to 125	None	None.
" "	" " " "	1 to 100	Slightly burned	25% dead.
" "	Scaline	1 to 25	None	All dead.
" "	"	1 to 30	None	All dead.
" "	"	1 to 20	Slightly burned	All dead.

PLANT.	MATERIAL.	STRENGTH USED.	EFFECT ON PLANT.	EFFECT ON ADULT SCALES.
Kentia forsteriana	Ivory soap	1 lb. to 4 gals. water—applied warm	None	None.
" "	" "	1 lb. to 4 gals. water—applied cold	None	None.
" "	Fels Naptha soap	1 lb. to 4 gals.—applied warm	None	None.
" "	" " "	1 lb. to 4 gals.—applied cold	None	None.
" "	Lemon oil	1 to 20	None	None.
" "	Commercial Kerosene emulsion	1 to 30	None	None.
" "	Tobacco soap	2 oz. to 1 gal	None	None.
" "	Tobacco soap, ½ lb. sulphur	2 lbs. to 12 gals., ½ lb.—boiled 15 min	None	None.
" "	Fir Tree Oil soap	1 oz. to 1 gal	None	None.
" "	" " " "	2 oz. to 1 gal	None	None.
" "	Nikateen	4 teaspoons to 1 gal	None	None.
" "	Goods Caustic Potash Whale Oil soap No. 3	2 oz. to 1 gal	None	None.
" "	" " " " " " "	1 oz. to 1 gal	None	None.
" "	" " " " " " "	4 oz. to 1 gal	None	None.
" "	Scalecide	1 to 40	None	None.
" "	"	1 to 20	None	All dead.
" "	"	1 to 10	Slightly burned	All dead.
Pandanus Pacificus	"	1 to 10	None	All dead.
Kenti forsteriana — Kentia Belmoreana	"	1 to 8	Slightly burned	All dead.
Pandanus Veitchii	"	1 to 8	Badly burned	All dead.
Livistonia rotundifolia	"	1 to 10	None	All dead.
K. forsteriana—K. Belmoreana	"	Undiluted	Badly burned	All dead.
K Belmoreana	"	1 to 5	Slightly burned	All dead.
K. Belmoreana Pandanus Veitchii	Black Leaf 40	3 qts. to 50 gals	None	None.
Pandanus Veitchii	" " "	6 qts. to 50 gals	None	None.
Pandanus Veitchii	Flowers of Sulphur	Applied by bellows	None	None.
Pandanus Veitchii—Ficus altissima	Kerosene emulsion, home made	1 to 3	Slightly burned	All dead.
Kentia forsteriana	" " " "	1 to 3	Slightly burned	All dead.
Livistonia rotundifolia	" " " "	1 to 3	None	All dead.
Kentia Belmoreana	" " " "	1 to 3	Slightly burned	All dead.
K. Belmoreana—K. forsteriana	" " " "	1 to 6	Slightly burned	All dead.
K. forsteriana	" " " "	1 to 5	Slightly burned	All dead.
Pandanus Veitchii	Scalecide	1 to 20	Slightly burned	All dead.
" Pacificus	"	1 to 20	Slightly burned	All dead.
Livistonia rotundifolia	"	1 to 20	None	All dead.
Ficus altissima	"	1 to 20	One leaf burned	All dead.
Latania rubra	"	1 to 20	Slightly burned	All dead.
Areca Verschafeltii	"	1 to 20	None	All dead.
K. forsteriana K. Belmoreana	"	1 to 30	None	80% dead.

PLANT.	MATERIAL.	STRENGTH USED.	EFFECT ON PLANT.	EFFECT ON ADULT SCALES.
K. forsteriana	Scalecide	1 to 30	Slightly burned	75% dead.
K. forsteriana—K. Belmoreana	Target Brand	1 to 10	None	All dead.
K. Belmoreana—K. forsteriana	" "	1 to 20	Slightly burned	All dead.
K. forsteriana	" "	1 to 30	Slightly burned	All dead.
K. forsteriana	H. C. N.—30 min	1 oz. to 100 cu. ft	All dead	All dead.
K. forsteriana	" " " " "	½ oz. " "	Badly burned	All dead.
K. forsteriana	" " " " "	¼ oz. " "	Burned	All dead.
Pandanus Pacificus—Livistonia rotundifolia—				
Pandanus Veitchii	" " " " "	¼ oz. " "	None	All dead.
K. forsteriana	" " " " "	⅛ oz. " "	Burned	All dead.
K. Belmoreana—K. forsteriana	" " " " "	1-16 oz. " "	None	80% dead.
Kentia forsteriana	" " " " "	3-32 oz. " "	Slightly burned	All dead.
" "	Nico-Fume	1 to 300	Slightly burned	None.
" "	Antipest	1 to 12	Slightly burned	All dead.
" "	"	1 to 16	None	None.
" "	Sherwin-Williams Lime and Sulphur	1 to 15	Slightly burned	None.
" "	Aphine	1 to 12	Slightly burned	None.
" "	Cooper's Summer Tree Spray	1 to 125	None	None.
" "	" " " "	1 to 100	Slightly burned	25% dead.
" "	Scaline	1 to 25	None	All dead.
" "	"	1 to 30	None	All dead.
" "	"	1 to 20	Slightly burned	All dead.

The temperature of the greenhouse varied from 75° to 92° F., when the above materials were applied, the average being 79°. Ten minutes after the operation, most of the plants were dry and at the end of fifteen or twenty minutes all were perfectly dry. The oils, however, remained on for several days.

Practically all of the insecticides except the sulphur killed larvæ and recent sets, but this was not taken as an indication of value. All of the plants received regular greenhouse treatment, which included almost daily syringing, consequently to be effective the insecticide has to kill within twenty-four hours.

In the course of the work it was found that various lengths of time elapsed before any injury became apparent. As a rule two or three days were sufficient. Sometimes a full week passed, and in one case when kerosene emulsion was used no injury took place until sixteen days afterward.

Livistonia Rotundifolia and Areca Verschaffelti seem to be the only plants which will stand Scalecide 1–20 without injury. The different Kentias stood this strength well at times, but on some occasions the leaves were burned slightly. The fact that this burning takes place makes it extremely risky to apply it on large numbers of valuable palms.

Assuming that the Scalecide is constant, the individuality of the plant is the chief factor, which determines whether or not the plant will be injured.

Scaline at 1 to 25 and 1 to 30 gives promise of being better than Scalecide, but further experimentation is necessary. Using hydrocyanic acid gas, the effects on the Kentias were discouraging. It failed to kill entirely when used at 1/16 oz. to 100 cu. ft., and at 3/32 oz. to 100 cu. ft. the plants were injured. However, Pandanus Pacificus, Livistonia rotundifolia and Pandanus Veitchii stood 1/4 oz. to 100 cu. ft., with no injury and complete killing of the insects.

Effect of Tobacco Extracts on Scale.

In order to demonstrate the futility of spraying palms with these materials and expecting to achieve complete extermination, a moderately infested Kentia Forsteriana was selected and the live larvæ and recent sets taken off every day. At the end of a

month the total was 472, making an average of fifteen per day. In order to have prevented breeding on this particular plant it would have been necessary to spray almost every day with tobacco extract.

Effect of Daily Syringing.

The frequent syringing which greenhouse plants, especially palms, receive, is no doubt responsible for the death of many larvæ. Several palms known to be infested by crawling larvæ were placed in such a position so as to receive the full benefit of the syringing. A careful examination afterward showed no larvæ. They had been washed off, either on adjoining plants or the bench. It is the impression among some greenhouse men that the syringing is largely responsible for the distribution of the scale. I think, however, that only comparatively few larvæ are carried by the water to other plants, inasmuch as the force, usually coming from above, would have a tendency to carry the insects to the bench. Of course the lateral spray could, and probably does, carry some.

Further experimentation against palm scales is under way.

Root Maggots.

Phorbia fusciceps Zeitt.

During the preceding summer a few materials were tried against infested radishes, with a view toward determining whether it was possible to kill maggots already established, and also prevent egg deposition. A farm in Cumberland county was selected, and on May 8th many flies were observed, a few eggs, and still fewer young larvæ. Egg depositions had evidently just got started. Plots were staked out consisting of 600 plants each, and the following materials applied with a watering can minus the sprinkler:

$HgCl_2$	1 oz. to 4 gal. water.
"	¼ " " " "
Sulfocide	1-200
KCy	1 oz. to 1 gal. water.

PLOT 1. Corrosive Sublimate, ¼ oz. to 4 gal. water. Applied May 9th, 12th and 19th. Foliage and plants or rather roots uninjured. On May 24th many maggots found.

PLOT 2. Sulfocide, 1 to 200. Applied May 9th, 12th and 19th. Plants entirely uninjured. On May 24th many maggots found.

PLOT 3. Potassium cyanide, 1 oz. to 1 gal. Applied May 9th. On May 12th the entire plot presented the appearance of having been burned over. Roots considerably shriveled. A few live maggots found in one of the partly shriveled radishes.

PLOT 4. Corrosive Sublimate, 1 oz. to 4 gal. Applied May 9th, 12th and 19th. Foliage considerably burned, roots stunted and taps of radishes considerably scarred. On May 24th many live maggots were found.

PLOT 5. Check, May 24th, many live maggots.

CONCLUSIONS. Fully two-thirds of the radishes in the entire field were infested, one-third being entirely unsalable.

The infestation was uniform throughout, and just as bad in the experimental plots as elsewhere. The materials failed entirely, the cyanide and corrosive sublimate injuring the plants. Taking into consideration the fact that the corrosive sublimate scarred the radishes from the surface of the soil to a trifle over an inch below, it seems that the ground rapidly takes up a lot of the insecticide before it has a chance to run the entire length of the radish.

The materials also failed as preventives. During the past season onion and cabbage maggots were present in Cumberland county in sufficient numbers to make their presence felt, but no unusual outbreak is recorded.

Certain phases of experimental work on the peach borer and the plum curculio were carried out during the present year by Mr. Patterson, and his report of the results follows:

THE PEACH BORER AND PLUM CURCULIO.

By RAYMOND S. PATTERSON.

The Peach Borer.

Sanninoidea exitiosa Say.

During the early summer of 1911 before the peach borer moth emerged Dr. Smith selected four rows of five to six year old peach in the State experiment orchard at High Bridge and caused the first row to be treated with tree tanglefoot, and the third with boro-wax. The second and fourth rows were left untreated as checks. Examination for borers on June 10th, 1912, gave the following result:

In the row treated with—

Tanglefoot—
In 17 trees were found 5 larvæ and 5 pupæ.
Check row—
In 18 trees were found 17 larvæ.
Boro-wax—
In 18 trees were found 2 larvæ.
Check row—
In 18 trees were found 13 larvæ and 1 pupa.

The five pupæ were found in a dead tree and had probably pupated early because of the uncongenial environment. Their presence can hardly affect conclusions as to value of the repellant for they must have been in the tree before it was applied.

The boro-wax proved injurious to the trees, and seems to be out of the question. On the young trees it formed a hard girdle and prevented a proper growth in the diameter of the tree. The bark of many trees thus treated cracked open beneath the boro-wax cracking the wax and exposing the living tissue of the tree.

Mr. Lovett, the maker, claims to have used it with success on many trees, but so far it has not been successful in the work, and it was decided to discontinue the experiment.

The tanglefoot seems to have been of some benefit and seemed to warrant a further trial, though its cost is prohibited on a large scale, for as used in the experiment its cost was approximately twenty-five cents per tree.

On June 13th the trees were again treated with tanglefoot. Most of the tanglefoot had been scraped from the base of the trees in the process of looking for borers, though it was well preserved above this zone, so the trees were only treated so as to make an entire covering from the branching of the roots to a foot above the ground.

At Vineland all the trees in the orchard had been "bored" by a field assistant in the horticultural department, and the usual wash applied to the trunks. The second row was arbitrarily selected for the test, and beginning with the east end of the row June 20th, twenty-eight trees were treated with ten and one-half pounds of tanglefoot. It was evident that some of the borers had escaped the search for there was still gum, full of "borings," or frass exuding from several trees.

The tanglefoot was not spread as high up on the trunks of the trees as was done at High Bridge in the original test, in order that the results might be compared when less was used and when the cost was correspondingly lower.

Of course, no conclusion can be drawn until an examination of the trees is made next summer.

The Plum Curculio.

Conotrachelus nenuphar Hbst.

While the injury done by the plum curculio in orchards with a heavy set of fruit may be negligible, for there must be a natural thinning of the young fruit in order that the remainder may be matured, in orchards where there is but a moderate set and where only perfect fruit is sold the injury may be very serious; at any rate the late Dr. Smith intended that the thorough investigation into the life history and habits should be continued to complete the work done by Mr. Stafford. But owing to the death of Dr. Smith, the press of routine work and the inspection of imported nursery stock which had to be done, little time could be given to the investigation work, but such as could be done was carried out along the same lines as the work of the previous year in the experiment orchards at Vineland and High Bridge.

On April 26th, three days before the first curculio was found in

1911, the trees were jarred on the outside rows, and on the two rows on the south side of the orchard, next to a cultivated field and where the invasion had been first found in previous years, again were found the greatest number of beetles. From the forty-two trees beaten five curculio were caught, but by this time the wind had become so strong that it was impossible to catch the insects as they fell from the trees.

The early date of the emergence of the curculio corresponds with the general early date of blossoming reported by Prof. Blake's men.

One of the curculio was still covered with dirt similar in color to that on which the orchard was growing, and a thorough search was made to catch any other emerging beetles. The dirt and litter from all likely spots in the orchard and neighboring hedge rows and unplowed strips were gathered up, bagged and shipped to New Brunswick; there to be sifted during such time as could be spared from the inspection of nursery stock. No curculio were found, a result agreeing with the results of the previous year's work.

On a pear orchard, not far to the south of the experiment orchard, the curculio seemed to be abundant, but the high wind prevented an accurate account.

Because of the time required in going to and coming from Vineland, and the little attention that could be given the work, a breeding cage was set up in the rear of the entomology building. The soil was made to correspond, as nearly as possible, to the orchard conditions and a seedling peach tree planted in it. A pile of rubbish, sticks, grass, &c., was placed in one corner.

About a pint of peach, plum and apple drops, from which full grown larvæ were emerging, were put in the cage on June 14th. As the larvæ emerged from the fruit they burrowed down into the soil almost immediately, and by evening there was no sign of any larvæ.

On June 26th, examined the peach drops; they were all free from larvæ and had begun to dry up and mould. I dug down in the soil immediately under the spot where the fruit had lain and found the larvæ about two inches in the soil, at about the level of the shale which, in all probability, was too hard for them to penetrate.

When disturbed they moved very freely and had not as yet changed to the pupal form. On July 13th, approximately one

month from the time the larvæ entered the ground, the first adult curculio appeared. It did not feed during the first day, but during the ensuing weeks there was plenty of evidence of feeding on the peach tree. As there were plenty of places in which the curculio could hide in the grass and rubbish no accurate count of the curculio could be made, and when it was too late it was found that there were holes which permitted the insects to escape. As it was learned last year the curculio never seems willing to stay where wanted, so the hoped for conclusions as to their hibernation are lacking.

The amount of work on mosquitoes is so large that in accordance with custom it has been embodied in a special section of the report.

The inspection of nurseries and apiaries under the direction of the State Board of Agriculture has been efficiently prosecuted and a number of important matters have developed which are treated in detail in the report of the State Entomologist.

REPORT ON THE MOSQUITO WORK FOR 1912

REPORT ON THE MOSQUITO WORK FOR 1912.

By THOMAS J. HEADLEE, *Ph.D.*

BRIEF HISTORY OF THE MOSQUITO WORK.

Previous to the year 1901 there had been sporadic local attempts to reduce the mosquito nuisance through elimination of breeding places, and Dr. Smith and his assistants had made more or less connected observations of the pests. In 1901, however, Dr. Smith started a systematic study of the problem of mosquito control and made such progress that his report of that year covered about sixty printed pages.

In 1902, operating under a law passed by the 1902 session of the Legislature, and financed by the sum of $1,000, which was contributed by Governor Franklin Murphy from his emergency fund, Dr. Smith secured Dr. Herbert P. Johnson to investigate the relation between the New Jersey species and the transmission of malaria, Mr. William P. Seal, of Delair, to study their natural animal enemies with special reference to fish, and devoted his attention, and that of his regular assistants, Mr. E. L. Dickerson and Mr. Hermann Brehme, to the study of the outbreaks and of the natural history of the species responsible. Here it should be said that Mr. J. Turner Brakely, of Lahaway, became a voluntary observer and began that series of studies that made him one of the most valuable of the contributors to the mosquito investigation.

The work of Dr. Johnson merely served to show that the distribution of recognized malarial carrying species was general. Dr. Smith, his assistants and Mr. Brakely, accumulated data to outline the role of the salt marsh species.

In 1903 the funds appropriated by the legislative act of 1902 became available and the study went forward more rapidly. The work of Mr. Seal continued. It had already shown that almost any fish will eat mosquito larvæ if it can get at them. The tadpoles of both frog and toad catch wrigglers by accident only.

The studies of Dr. Smith, his regular assistants and voluntary observers, followed the line of the previous year.

In 1904 Dr. Smith published his report of 482 pages on the mosquitoes of New Jersey and gave a detailed statement of the results of all the studies made in New Jersey. He showed that the general mosquito problem had, anywhere within forty miles of the salt marsh, to do with the elimination of the salt marsh as well as the fresh water breeding species. He found that breeding in the salt marshes exclusively, some of the salt marsh forms will rise and fly many miles inland, completely swamping the efforts of an inland municipality to free itself from the pest.

This discovery explained the failure of local attempts and indicated, when the size of the area involved was considered, that the elimination of the salt marsh mosquitoes was essentially a state rather than a local problem.

Dr. Smith showed also in this report that the mosquitoes of New Jersey, contrary to popular notion, could not breed except in water, and that the elimination of the mosquito was entirely practicable through draining and filling of pools, proper grading to afford drainage, screening rain barrels and cisterns or stocking them with fish, burying old tin cans and other waste receptacles where water may accumulate and stand, cleaning the edges of brooks and ponds and stocking them with fish when fish are absent, and oiling sewer catch basins, lot pools and other places where for any reason other methods are impracticable.

In accordance with these findings as to the nature of the salt marsh mosquito problem, the Legislature of 1905 so modified the law that such communities as had salt marsh within their borders could obtain state aid in their treatment. Four thousand dollars were made available in 1905 and $6,000 in 1906. For one reason or another only one municipality—Elizabeth—took advantage, and, with the exception of $1,000 spent there, the whole $10,000 was turned back into the treasury. In 1905 a survey was made of the entire salt marsh and estimates of the cost of draining the whole area were prepared.

Large contributions to knowledge of mosquito natural history and of larvicides were made during these two years.

In 1906 the Legislature passed an act providing for the elimination of mosquito breeding places on the salt marshes (Chapter 134, Laws of 1906). Drainage under this act has gone forward as

rapidly as the funds would permit until, with some minor exceptions, all the salt marsh between Secaucus to a point a little south of Barnegat has been ditched. The problem of preventing the breeding of the salt marsh mosquito within these limits is a matter of re-establishing drainage lines interfered with by railway grades and garbage dumps, the cleaning of clogged ditches and the cutting of ditches where through error of judgment insufficient drainage was established or where in the course of salt marsh, evolution areas once free from breeding become breeders.

Many surveys have been made and some actual ditching has been done south of Barnegat, but there has not been enough of the latter to result in appreciable diminution of the mosquitoes of that section.

Record of Work Done and Money Expended in Ditching the Salt Marsh.

Period.	Acres.	Feet of ditching.	Cost to the State. Ditching.	Making necessary studies and issuance of publication.	Administration.
Up to 1907, as reported...	15,851	2,215,524	.....	$11,000 00	.....
In 1907, as reported.....	10,951	1,505,524	$19,400 00	.....	$4,100 00
In 1908, as reported.....	6,669	888,650	15,758 00	.....	4,242 00
In 1909, as reported.....	2,672	365,800	9,917 00	539 70	4,543 30
In 1910, as reported.....	4,650	350,000	7,471 50	.....	2,528 50
In 1911, as reported.....	8,528	712,000	19,650 00	.....	5,350 00
In 1912, as reported.....	6,197	1,000,180	21,650 00	.....	3,350 00

In addition the actual expenditures for ditching, investigation, publication and administration during the years 1907-1912, about $11,000 were expended in investigation between 1901 and 1907, making a total expenditure for all purposes of $129,499.50.

Conclusions and Outlook.

At a cost of $129,499.50 Dr. Smith and his assistants, in spite of many drawbacks, have found how the New Jersey mosquito can be controlled, and have, with minor exceptions, so drained the salt marsh from Secaucus to Barnegat that the prevention of salt marsh mosquito breeding is a matter of keeping the present drainage systems in operation, of cutting such additional ditches as are necessary to keep pace with the evolution of the marshes, and to correct mistakes made in the original ditching.

The resulting reduction of the salt marsh mosquito gi
tection to Bergen, Morris, Essex, Union, Somerset, Middle
Monmouth counties and renders the problem of becoming m
free mainly the suppression of local breeding forms.

Some municipalities, notably Newark, have made grea
ress in the suppression of the local breeding species.
the past season, operating under a new State law, Essex and
counties have made satisfactory progress in mosquito contr

Nearly all of the South Jersey coast for forty miles in
subject to the great flights of salt marsh mosquitoes bred
costal marshes below Barnegat, and will not be free u
salt marsh is drained.

The drainage necessary to mosquito destruction will i
ally just about double the yield of hay and increase the v
real estate holdings along shore by 25 to 100 per cent.

In round numbers there are 200,000 acres of salt mar
the ability in an undrained condition to yield about 300,0
of hay having a gross value of about $2,400,000. The c
necessary for elimination of salt marsh mosquito breedi
increase the annual productive power of the State by ab
000,000. The increase in the ratables due to rise in v
real estate, at present low because of the mosquito pest, is, w
present data, impossible to figure, but would undoubtedly
to many millions of dollars. A well-informed citizen of
gat said recently to the writer that the freedom from mo
would mean from a 25 to 100 per cent. increase in the
real estate in that section.

In addition to the money return the people of New Jer
live within the range of the salt marsh mosquito would r
calculably large benefits in comfort and health.

WORK OF 1912.

The salt marsh work of 1912 involved the cutting of 1,0
feet of ditches, 310,000 feet of which were in meadows
worked upon, and 726,180 on meadows hitherto untouched.

The total appropriation for the fiscal year amounted to
of $25,000, with which work was done as follows:

available $25,000 00

drained.	Acres.	Feet of ditching.	Cost.	
h of Lavalette	.....	40,000	$900	
Township	3,400	310,000	6,000	
Witch	.....	6,000	250	
Township	650	159,580	3,400	
Township	2,112	161,600	2,900	
north of Gunning River....	.....	20,000	500	
south of Gunning River....	.....	29,000	700	
cs additional	.....	40,000	800	
port additional	.....	30,000	600	
d "	.....	42,500	850	
City "	.....	35,000	700	
Creek "	.....	30,000	600	
Creek "	.....	35,000	700	
iffs Creek additional.....	.....	15,000	300	
Township and Bayonne				
ıship additional	.....	35,000	700	
Island additional	.....	25,000	500	
y "	.....	22,500	450	
	6,197	1,036,180		$21,650 00

ving a balance of $3,350 for the expenses of administra-
which includes salaries and traveling expenses.

of the meadows between and including Secaucus and Barne-
ere inspected and some were given further ditching. Some
rs were made in regions south of Barnegat. Mr. Hermann
ne was in full charge of this work, and his report follows.

SALT MARSH WORK IN 1912.

By Hermann H. Brehme.

Secaucus Meadow.

s meadow was carefully looked over in the latter part of
mber and October in 1911 and again in March, 1912. Notes
made of all the danger points, and on the first inspection in
it was seen that more work would be required. It was
ıt that to delay matters very long would mean a crop of
ıitoes. I therefore asked the director of the Experiment
n to set aside the sum of eight hundred dollars ($800) and

the work was started immediately after an agreement was made with Mr. Manahan to do the work. A great number of new ditches were cut; pools that did not drain readily were either connected by spur ditches or filled in with sods so that there would be no danger of future breeding. While the work went on as rapidly as could be expected and was pushed in every way the larvæ gained on us, and would have had a good chance of getting out, had not Mr. Delaney, who was overseeing the work in general, come to the rescue with several barrels of oil. This was sprayed on all the pools, and the work so thoroughly done that none escaped.

The work of ditching and filling went on steadily, and every ditch was in such shape in May that mosquitoes will have a poor chance to mature on that meadow in the future.

To eliminate the mosquito breeding on that meadow means a great deal, for Snake Hill is adjacent, and on this there is the Tuberculosis Hospital, where the patients sleep in tents and in the open. Last year they were very much annoyed by this pest. But several inspections had been made by Mr. Delaney and myself up to May 21st of this year, and up to that time not a single mosquito was found, either on the meadow or on Snake Hill.

Mr. Henry H. Brehme made an inspection on May 29th, and the entire meadow, with the exception of three small pools, was found dry and no mosquitoes were found anywhere in that vicinity.

Several more inspections were made during the season, and conditions always were found good, so that with a little attention this meadow should be entirely free from mosquito breeding next season.

Jersey City Meadows.

When inspections were made on this meadow early in March it was seen that a little additional work was necessary, and that the cost would amount to about $700. This sum was set aside by the director of the Experiment Station and the work started in the latter part of April. Mr. Delaney made many inspections of this meadow in 1911 and had noted all the danger points. The men were put to work on the points where the greatest danger existed, and by the middle of May every breeding place on the

meadow was eliminated. It seems likely that the few mosquitoes found on the meadow on May 20th came from Point-No-Point, where breeding had been going on. Another inspection was made by Mr. Henry H. Brehme on May 25th. The entire meadow was found in good condition with no breeding going on and no adult mosquitoes were found. An inspection was made by myself on June 11th, and conditions were found very good, no breeding going on anywhere and no adult mosquitoes were to be seen. The same conditions prevailed during the rest of the season.

Point-No-Point.

This meadow had been greatly improved during the winter of 1911-12 by filling in. The worst breeding places were covered with soil from two to six feet, and in this way millions of eggs were buried. The filling, however, did not cover the entire territory, and there are still some breeding places left which need attention. The first inspection was made on April 9th by Mr. Henry H. Brehme. He reported breeding west of the filled territory, and especially along the East Jersey Water Company Pipe Line. The conditions were reported at once to Mr. Delaney, who has charge of this section. Mr. Delaney promised to have the pools oiled before the brood could mature. No inspection was made until May 15th, when another brood of young larvæ were found, and Mr. Delaney was again notified of conditions as they existed. In going over the meadow on June 8th to experiment with a new preparation for killing mosquito larvæ it was found so dry that not even an attempt was made to try the material. The oiling carried out by Mr. Delaney, together with climatic conditions, killed this entire brood. The process of filling in continued, and in order to proceed more rapidly the pumping of sand was supplemented by dumping of garbage brought from New York City. This transformed the salt marsh into a typical *pipiens* breeding area. It was necessary to oil along the edge of the dump, and this will have to be continued until every thing is filled in. Several inspections were made during the latter part of the season, and more or less breeding was found. In most cases *C. pipiens* was the predominant form.

Kearny Meadow.

Heretofore, because of a press of more important work in the spring of the year, this meadow was not inspected until June. This season, however, we were able to give attention at a critical time, in April, and observations were continued throughout the season.

The first place looked over was the area between the turnpike and the Delaware, Lackawanna and Western railroad east of the Swift plant, which had been ditched in June, 1911, and stocked with killies. At the time the ditches were made the weather became so warm that very few killies could be transported and it was possible, therefore, to stock only a part of the ditches. It was necessary to put more fish into the ditches in time to destroy the larvæ that were present on the meadow. This task was turned over to Mr. Henry H. Brehme, and enough fish were introduced to destroy the entire brood.

At the time this area was ditched it was so hemmed in by roads and railroads that no outlet for the ditches could be made, except in the lower part of Franks creek through which the Passaic river sewerage would back up on the high tide and cover the meadow. On this account only blind ditches were cut. These intersected one another and the surface water drained into them very nicely. Fish put into these ditches did very well and kept the breeding down last year. Most of them survived the severe winter of 1911-12. Additional fish were, however, introduced in April and the entire brood destroyed.

The Franks creek section was looked over about the same time and the development of a tremendous brood noted. The section where this brood was harboring is located on the east side of the creek beginning at the turnpike and running north to a point only a short distance east of Schuyler avenue and is about one mile in length and two hundred feet in width. Mr. Amerman, inspector for Kearny board of health, was at once notified of this brood and took the matter up with Mr. Delaney. Town and county working together, nine barrels of oil were sprayed on this section and the entire brood destroyed. As a direct result the adults were greatly reduced in numbers both in Hudson and Essex counties.

On June 1st Messrs. Henry H. Brehme and Amerman went

over Franks creek section carefully and not a larva was found. Five adult mosquitoes were captured which were identified as three *pipiens*, one *cantator* and one *sollicitans*.

Breeding was found along this section in early September and Mr. Amerman was notified. An inspection made by Mr. Henry H. Brehme on September 26th showed only scattering larvæ.

Bergen Point and Bayonne.

Some very bad breeding places were discovered on these sections early in May and immediate action was necessary to prevent widespread breeding. The matter was carefully considered by Mr. Delaney and myself, and it was thought best to clean up this section and let Kearny township wait until the Hudson County Mosquito Extermination Commission got sufficient funds to clean up that section. (Since then the commission was provided with funds on which they can begin work after December 1st of this year.) Six hundred dollars of the amount that was to have been spent in Kearny township was used to better advantage along Kill von Kull in the cutting of about 30,000 feet of ditches which gave great relief to the lower sections of Hudson county. The catch-basins in Bayonne were oiled during the season by the board of health and this kept the local breeding down to such an extent that that section of the country was practically free from mosquitoes during the past season.

Newark Meadow.

An inspection of this meadow made early in March showed some of the ditches closed by the pressure of garbage dumping too close to their edges. Mr. Dobbins was notified of the conditions and the ditches were repaired. The ditches on the Hamburg Place section where the outlets have all been cut off with the exception of two, were in such a shape that the water could not readily drain off. The work of cleaning the ditches on this section was taken in hand when Mr. Dobbins was notified of the danger and progressed so rapidly that, assisted by favorable weather, the first brood was destroyed.

In the meantime I asked the Director of the Experiment Station to set aside $2,000 for 100,000 additional feet of ditching,

and an agreement was made with Mr. Jesse P. Manahan to put in the required number of feet on three different sections where more work was required. The agreements were signed on April 15th, and the work was started immediately afterward with a good force of men. The worst sections were first gone over to relieve the worst conditions in getting the water and larvæ off. In this way practically the entire first brood was killed. But the very high tides on April 29th and 30th, which put the entire meadow from ten to fourteen inches under water, permitted a new brood to hatch. The work by this time was, however, so far advanced that the water ran off nearly as fast as it got on, and it was noted, on May 4th, that fully 75 per cent. of the larvæ which hatched in the high tides of April 29th were destroyed by the drying out of meadow. The heavy rains of May 5th and 6th refilled a few of the pools, but they dried out in two or three days, destroying all larvæ contained. Rain set in again on May 9th, and for three days it rained continuously. East winds brought in high tides so that conditions were thoroughly bad. Clear weather followed on May 11th with a good stiff westerly wind. This brought very low tides and dried many pools, but the larvæ were so nearly full grown that a crop was sure to get on the wing, and on May 15th the first *Cantator* reached the city of Newark. But the crop was small and most of it came from the Waverly section of the Newark meadows. A little oiling by the Newark authorities would have prevented it, but while flags were stuck up to indicate breeding places nothing was done until laborers got to such spots to connect the pools, and that was, in some cases, as much as three months. In the meantime brood after brood emerged. The State work was going on in good shape and many millions of larvæ were run off the meadow.

Another inspection was made on the Waverly section on May 24th, and many pools, with larvæ and pupæ were found in the sections where the ditches were not cleaned and another small crop was about ready to emerge. Mr. Dobbins was again informed of the conditions and he gave orders to oil the pools. The work of cutting new ditches on this section was at this time taken up with State funds under my personal supervision. The most dangerous points were eliminated at once, and uncountable numbers of larvæ and pupæ run off. A little oil would have checked the remainder, but it was too late to get them all, as thousands were hatching every hour, and most of them got out before the oil arrived.

This was two days after the conditions were reported to Mr. Dobbins, who, at this time, had been appointed chief inspector for Essex County Mosquito Extermination Commission. The work done by the State was finished in good shape on May 31st. All the old ditches were connected by new 10 x 30 inch ditches, and if the old ditches get the proper cleaning in the future no breeding should take place on this area.

The work of cleaning old ditches was started in the proper way on May 29th, when Mr. Erhard was put in charge of the meadow work by the Essex County Commission. He made the laborers go down two feet or more, and good results were obtained at once. Heretofore not more than six inches of the mud had been removed.

On June 6th Mr. Henry H. Brehme made an inspection of the Waverly and Bound Creek sections. Conditions were found in fair shape and very few pools with larvæ were found. Mosquitoes at that time were not at all abundant.

On June 10th I made a thorough inspection of the Waverly, Bound Creek and Maple Creek and Hassock sections. These are the most prolific breeding sections of the Newark meadows, and more than 10,000 pools have been found on these areas. Considerable work was done here early in the season by the State with good results. Less than a dozen pools were found to contain water. Only a very few larvæ were found, and less than twenty-five dilapidated specimens of mosquitoes.

The Newark meadow up to this time never was in such good shape. Only occasional inspections were made during July and August. Once early in August breeding was found on the Hamburg place meadow, and conditions were promptly reported to the Essex County Commission. The writer attended the meeting of the commission on August 19th, and pointed out the fact that the most dangerous period of the season was the early part of September when the tides run high and large broods emerge. The question was whether to use oil or do permanent work. On my suggestion 150,000 additional feet of ditching was put into the meadow. Inspections were made in September, and the meadow was found to be more or less covered with tide water. A great number of fish were brought in on these tides which kept the breeding down, so practically no mosquitoes got out and no salt marsh species were found in the city.

City of Newark.

The city of Newark was practically free of mosquitoes all season. The work done on the meadows early in the year by the State cut down the salt-marsh breeding over 90 per cent., and the only flight of salt-marsh mosquitoes that invaded the city was the May brood, which was a very small one. The local breeding was cut down fully 95 per cent., and the credit for this should go to the Essex County Mosquito Extermination Commission. Although this commission did not get to work until the middle of May it showed excellent results. The house-to-house inspections were the first part of their work, and these solved a good part of the problem. Many barrels, tubs, cans, &c., in which breeding had been going on for years were found by the inspectors and disposed of. The catch-basins received full attention and there was no chance for mosquitoes to hatch. People could sit on their porches in perfect comfort, and the odors of oil of citronella and Chinese punk were absent. Such conditions never existed in the city of Newark before.

Elizabeth Meadow.

The first inspection on this meadow was made February 17th. Conditions on the east side of the Newark and Elizabeth branch of the Central Railroad of New Jersey were bad, and a thorough inspection was made at once. It was found that the railroad company had laid a series of new tracks into their yards near Elizabethport for a distance of nearly a mile. By doing this work the ditch along this railroad was entirely filled in, stopping up the outlets of some twenty narrow ditches and putting the nearby meadow under water. Mr. Louis J. Richards, health officer of Elizabeth, was at once notified of the condition of affairs and he immediately took the matter up with the officials of the Central railroad to reopen a ditch along the line which had been filled in. I went over the ground with Mr. Richards and pointed out the serious points, with the result that the railroad authorities cut a good ditch in place of the one which they had filled in. This was done in time to eliminate the greater part of

the larvæ. Thus, while not all were eliminated it is safe to say that less than 20 per cent. came to maturity. Several more inspections were made on this meadow in March, and it was determined that more ditches were needed, especially near the Newark and Elizabeth city line. It was determined that another 100,000 feet of 10 x 30 inch ditches were needed, and therefore I asked the director of the Experiment Station to set aside the sum of two thousand dollars ($2,000) for this additional work. An agreement was made with Mr. Jesse P. Manahan on April 17th to cut the number of feet required and work was immediately begun in order to prevent the emergence of as many mosquitoes as possible. Progress was a little slow at first, because the soil on the meadow on which the most breeding occurred was so firm that it was hard to get the spades through, and holes twenty feet away from the ditch would not readily drain so that, to make conditions safe, hundreds of holes had either to be connected by spur ditches or filled in with sods. While this kind of work took considerable time many millions of larvæ were, nevertheless, killed by the filling in process, and less than 5 per cent. hatched on this section of the meadow. On May 7th an inspection was made along the edge of the highland from Waverly to Elizabethport to determine whether any mosquitoes had left the meadow, but on the four-mile trip not one specimen was found, although numbers occurred where the work was going on. Though the cleaning up work had only started at this time, wonderful results were obtained. The meadow on May 7th was practically dry, and 90 per cent. of the second brood had been killed by quick drainage where the new work was done. Rain fell heavily on May 5th and 6th, and most of the pools were filled with water. While the wind was steadily from the east for three days, there were only ordinary tides with one or two exceptions which covered the meadow, but were not sufficient to bring fish into the pools. Pools twenty or thirty feet away from the ditches held very little water, and then only on the flood tides. Practically all the water drained out of the pools on ebb tide and no water remained after May 7th.

The Great Island section, which is so bounded in by the railroad that no effective drainage can be made, had another good sized brood developing. Mr. Richards was notified of the condi-

tions on this section on May 2d, and the matter was attended to immediately. Three barrels of oil were carted to it on May 3d, and the spraying was done on the 4th. Trips were made through Great Island on May 13th and 20th, and no mosquitoes were found on the wing.

The section near the Elizabeth Almshouse, from which many broods escaped, was taken in hand on May 13th by putting a gang of men in, and by May 20th that meadow was laid in a perfectly dry condition. With a little care it can be kept in its present condition and no mosquitoes should breed there hereafter. The work that was undertaken by the State was finished on May 31st. An inspection was made on June 7th, and the meadow was found in a dry and good condition. Mosquitoes were rare except in the place known as the "Y," which is hemmed in by the railroad embankments and on which oiling is the only remedy possible. The heavy rains filled this place and no oiling was done, so a small brood of *sollicitans* hatched, but its numbers were so few that it was not noticed.

The new moon tides spread over some parts of the meadow between June 18th and 24th, and the water stayed on the Great Island section long enough to hatch a small brood of *sollicitans*. This brood also stayed at home on the meadows and none were noticed in Newark or Elizabeth. The meadow was again dry on June 2d.

The Union County Mosquito Extermination Commission got to work on the meadow by this time, and an attempt was at once made to eliminate the breeding places near Great Island. I went over the ground with Mr. Richards and we determined that the only way to get the water off on the east side of the island was to cut a wide ditch into Woodruffs creek and through the railroad spur. The matter was taken up with the Central Railroad Company and they promised to build a culvert whenever the ditch was made. This was very satisfactory, and an agreement was made by the Union County Commission with Mr. Manahan for a wide ditch to relieve the bad condition. A good ditch, over 4,000 feet in length, was made five feet deep and five feet wide. This ditch was finished late in July, but the railroad company did not build the culvert until late in August. In the meantime the water lay stagnant on the south side of the spur and con-

siderable breeding went on. After the culvert was built it improved conditions greatly, and with a little additional work next year this place will be perfectly safe.

City of Elizabeth.

The conditions within the city of Elizabeth were good throughout the season. The cleaning up of the salt marsh by the State in early spring prevented salt marsh mosquito invasions. Although the Union County Mosquito Extermination Commission did not get to work until the first part of June they were able to check the local breeding to such an extent that no complaints were heard. The pools and catch-basins were kept under close observation, both by the State and county, and only on a very few occasions was breeding found. Mr. Henry H. Brehme was sent over this territory regularly, and his reports on the whole were always good.

Linden Meadow.

This meadow was ditched in 1907 under great difficulties. Some of the owners objecting so strenuously that certain sections were not properly ditched and left to convince the owners of the results in other sections. The ditches that were put in on this meadow in 1907 have stood wonderfully and given excellent results. No mosquitoes emerged on the drained areas and very few from the undrained sections, as the ditches were so placed at the time that it would take most of the water and drain the majority of pools. Inspections were made over this meadow early in the season and the usual conditions found. More work was needed, and as the Union County Commission was then already in existence the work was taken up by that body and about 40,000 additional feet of ditching done. There are still some few sections left that require a little more work, and that will now gradually be done as there seems to be no objection by the owners and the commission can proceed unmolested. When Dr. Smith tried to relieve conditions in that region he struck his hardest proposition, but conditions have since changed so the owners realize that the drainage work is for their benefit as well as for the general public.

The work that was done on this meadow in 1907 reduced the mosquitoes fully 90 per cent., and it will be only a matter of another year until the remaining 10 per cent. will also be eliminated.

The hay crop on this meadow has increased to double the previous amount, and it is not as difficult to cut as before the meadow was ditched.

Woodbridge Meadows.

The first inspection on this meadow was made on June 28th. Conditions at that time were found good with the exception of the area near Boynton Beach, between the New York and Long Branch railroad and the county road on the north side of Woodbridge creek. This section did not work out as well as had been expected, and a little additional work will be necessary in 1913 to make it safe from breeding. The Woodbridge meadow includes the Sewaren section also. Very few mosquitoes got out from that meadow, as nearly every ditch has two outlets, so in case one end does get blocked there is another to do the work.

The ditches on this meadow should, however, all receive a little cleaning early in the spring, and to get everything in proper shape some additional work, costing about fifteen hundred dollars, will have to be done. Mosquitoes were rare all season, the only heavy flights appeared in early September, and this was due to the heavy rains and continual high tides which kept those meadows wet for a period of three weeks.

Raritan Meadows.

An inspection was made on this meadow on April 10th by Mr. Henry H. Brehme. The ditches were found in good working order and there was very little breeding. This meadow is always more or less flooded in early spring because of high tides and freshets which come down the Raritan river. The meadow is, however, now so well ditched that very little breeding can go on. With the climatic conditions in favor of the absence of mosquitoes, so few were found that it is evident that the ditches are efficient and are keeping the meadow in good shape, at least after the middle of May. To overcome the early spring trouble, however, 50,000

additional feet of ditching should be put in on this meadow, work which will probably be done in 1913.

I, myself, made an inspection on June 12th and found everything in good condition, with no breeding and no adult mosquitoes. Another inspection was made on July 3d and conditions again found good.

The ditches will require a cleaning next spring to be safe, but the cost will not exceed $300 for the work that needs to be done.

Cheesequake Meadow.

The first inspection of this meadow was made on April 26th and the ditches were found to be in excellent condition. Most of the ditches were found as good as when first cut. Places where there were deep holes in 1908 were found to be grown up with grass and sedge, and in most instances as firm as the regular meadow. The meadow was found in rather a dry condition in spite of the fact that considerable rain had been falling for some time and that tides had been running high. It was seen at once that it was safe to predict no early flights, as larvæ were very scarce. To make sure of this point, I, in company with seven gentlemen, made another inspection on May 5th to determine whether hatching of adults took place up to this time. A considerable part of the meadow was gone over, but with a most careful search only a single *C. sollicitan* was found. A trip was then taken through the woods and fields on the edge of the meadows, but in nearly two hours' tramping only three *C. canadensis,* a woodland species, were found, and not one of the salt marsh species.

An inspection was made on June 5th and the meadow found in good condition with the exception of about one acre on the north side of the county road where a culvert is laid so that not all the water can run off after high tides. On this section a little breeding was present, but the rest of the meadow was found dry and free from breeding.

Still another inspection was made on June 29th and everything found in good shape, no water lying anywhere and no mosquitoes on the wing. The tides had been running very high for nearly a week, but all the water drained off in good shape and no mosquitoes got out.

On July 5th another inspection was made, not so much on the meadow itself as in the woods on the edge of the meadow, to determine whether any salt marsh mosquitoes were harboring there. A walk of several miles through the woods and fields was taken and only two mosquitoes seen; one was a *C. sollicitans* and the other *C. tæniorhynchus*. I spent four nights at Morgan, and in that time not a single salt marsh species was seen; several *pipiens* which bred in the rain-water barrels along the beach were caught, otherwise that section was free of mosquitoes.

Inspections were made regularly during August and September, but no breeding was found until the last of August. Then, after the tides had been running high for two weeks which kept the meadow wet all this time, a brood of *C. tæniorhynchus* was enabled to emerge. These mosquitoes were troublesome in the first week of September. No more hatching took place after that time.

The absence of the mosquitoes has improved conditions greatly at Morgan. In 1908 only a few people lived in this section, and in 1912 there were over fifty tents and bungalows on Morgan Beach and fifteen bungalows on Morgan heights.

Prior to 1908 this section was unbearable on account of the tremendous flights of mosquitoes that came from the adjacent meadows.

Cliffwood–Matawan Meadows.

The first inspection was made on the above meadows on June 14th. The tides at that time were beginning to run high and some parts of the meadows were flooded, so inspections were repeated on June 20th and 21st. While the tides were just about getting back to normal the meadows were already dry. There may have been some larvæ hatched from eggs, but none of them matured, the period of seven days being too short.

Inspections were made on these meadows every two or three weeks for the balance of the season, and they were always found in good condition. Next season the ditches should be cleaned; and this can be done for about $100.

Keyport–Union Meadows.

These meadows were carefully looked over on May 4th, and at that time everything was found in good condition. No breeding was going on. The ditches on these meadows are standing well and to all appearances they will need no attention for some time to come.

Two other inspections were made in the latter part of the season and everything was found in good working order. There had evidently been no breeding on that section during the entire season and mosquitoes have not been troublesome in that vicinity at any time since the work was finished in 1908.

Keansburg Meadow.

The Keansburg meadow was inspected May 27th and found in good condition. Ditches that were cut on this meadow in 1908 are still in good shape and doing good work. No breeding was found, neither were any salt marsh mosquitoes located on these meadows. Some of the old ditches that were cut many years ago by the owners are in bad shape and are liable to become mosquito breeding places. But there was no danger at the time the inspection was made, as killies were pretty well scattered all through those places where breeding had once been possible.

To make these danger points safe about $500 will have to be spent on this meadow early next spring.

Another inspection was made on August 23d and conditions found good. Mosquitoes were scarce during the past season in the vicinity. What few there were were *pipiens,* with occasional small flights of salt marsh mosquitoes which undoubtedly bred in some of the grown up ditches.

Port Monmouth.

This meadow was found in good condition on June 3d. The ditches were in good shape and there were no signs of breeding. This work was done in 1908 and a very nasty stretch of meadow was made practically free from mosquito breeding.

Formerly, farmers in that section had to cover their horses and

themselves for protection against the attacks of the mosquitoes, but there have been no complaints from this section since the work was done. No additional work seems necessary at the present time.

Belford Meadows.

An inspection was made on this meadow on May 31st. The ditches that were cut in 1908 were all in good working order, and the meadow found in the best of condition where the regular 10 x 30 inch ditches had been cut. This, however, cannot be said of the meadow that borders on Atlantic Highlands. The contract for that section was given to Mr. William B. Smith, then owner of the meadow. The work that was done was not up to the standard depth and width, but as the promise was made at the time that the meadow would be filled within two years the work was thought sufficiently good to last that period. Mr. Smith, however, has not kept his promise as to the filling in, and while some of the ditches are still working in a fair way it means expenditure of about $300 to get everything in proper shape.

No salt marsh mosquitoes were found at the time of inspection and no reports were made of any being present during the past season, although there may have been a flight early in September due to the high tides which undoubtedly covered that meadow.

Atlantic Highlands.

The meadow along Many-mind creek was inspected on June 4th. This is only a small strip of meadow on both sides of the creek. Many-mind creek was made deeper and bulked-headed in 1906, so as to take the water from the swamps west and north of Atlantic Highlands, which used to run down and lie on this meadow.

It was thought advisable to drain the meadow at the same time, and the borough of Atlantic Highlands, taking advantage of the law then in force, secured aid to the extent of $375.

The bulkhead part of the work was done in good shape. But as the contract was given out by the borough it was awarded to a contractor who was not capable of doing good ditching work.

While some of the ditches are still working fairly well, others are closed up because they were not dug deeply enough. It will cost a hundred dollars to get the ditches in proper working order, and this will probably be done early next year.

The few good ditches kept that meadow practically free from mosquito breeding, and Atlantic Highlands got no salt marsh mosquitoes to speak of. On the other hand they supplied themselves well with *C. pipiens*. I went through the town and found many places where this species was breeding in great numbers, and especially along the trolley line in the western part of the town. No complaints, however, came in about mosquitoes being troublesome, and nothing was done to relieve conditions.

Water Witch.

The meadow at Water Witch was inspected on March 29th. A considerable portion had been filled in, but a strip large enough to supply Water Witch and surrounding places was still left undone. As Mrs. F. A. Wright was anxious to keep that section as free as possible from mosquitoes and as all the local breeding placed had been kept oiled, it was thought best to clean up the meadow. The director of the Experiment Station was asked to set aside the sum of two hundred and fifty dollars ($250) for the work.

The contract was awarded to Mr. Manahan, who commenced work early in May, and the meadow was put in such shape that no more breeding can take place if the ditches are kept open.

Several inspections were made over this meadow during the season and no breeding was found. Such adult mosquitoes as were found undoubtedly came from Sandy Hook, which lies directly across the bay where practically no work to eliminate the mosquitoes has thus far been done.

Shrewsbury River Meadows.

The meadows on both sides of the Shrewsbury river were carefully inspected on June 13th and found in the best condition, neither larvæ nor adults being present. These meadows are pa-

troled by two men whose duty it is to keep the ditches that were cut in 1904 in shape. It is evident that their work is properly done.

Some of the ditches on the Monmouth Beach side were recut last year and made the standard size, 10 x 30 inch. This was practically the first work that was done in the State, and in 1904 we thought a 6 x 24 inch ditch was sufficient in size, but while they work in some places, the larger sized ditch works better and the difference shows on this meadow. The larger ditches can be readily cleaned if they get clogged, while the smaller ones cannot, and for that reason the larger sized ditches were put in in place of the smaller ones.

Most of the outlets of these narrow ditches were made directly into the river at first. This was a mistake, as the outlets got more or less filled and clogged with sand brought in in the wake of steamboats. To avoid this most of the outlets of the standard size ditches were made into creeks wherever these were available, and this trouble is now practically eliminated.

Inspections were made in July, August and September, and conditions were always found good, and salt marsh mosquitoes were not troublesome anywhere along Shrewsbury river.

Manasquan–Point Pleasant Meadows.

The Manasquan and Point Pleasant meadows were inspected at three different times during the past season. Conditions were found good, and little if any breeding went on until the first part of September, when a fair sized brood emerged as a result of the high tides which kept this meadow covered with water for two weeks or more.

The ditches on these meadows are still in good condition, but almost every one needs a little cleaning. This will probably be undertaken early next spring. The total cost for putting the ditches in proper shape on both meadows will not exceed $100.

Manasquan was not free from mosquitoes this past season. They had some invasions, but these were all home bred and consisted of *pipiens, sylvestris* and *anopheles,* which are bred in rain-water barrels and in the little brooks and swamps in and around Manasquan.

Nothing was done to eliminate these species, and the same trouble will continue until a county commission is appointed both in Monmouth and Ocean counties to eliminate such places.

Borough of Lavallette.

This borough lies on the east side of Barnegat bay, in Berkley township, Ocean county; the northern boundary line is Chadwicks and the southern line Seaside Park. It has salt marsh about two and one-half miles in length and one mile in width, on which there are many prolific mosquito breeding places which supply Seaside Park as well as Lavallette.

Several inspections and surveys of this area were made and it was seen that all the mosquito breeding places could not be eliminated except at a great expense by cutting canals under the Pennsylvania railroad to get water out from between the railroad and county road. This could be successfully done, but the work would probably stand for only a short time before the entire back meadow would be filled in by improvements which are going on rapidly in that region, and money expended in places where improvements are about to take place would only be wasted. Therefore, only the typical salt meadow which lies on the west side of the railroad up to the shore of Barnegat bay was considered, and it was figured that it would take about 40,000 feet of ditching to make it safe. The contract was given to Mr. Jesse P. Manahan, of Red Bank, New Jersey, for $900. Work was commenced as soon as the 1912 appropriation became available early in November, and was completed early in December, too late, of course, to note the results. A close watch was kept on this area in 1912 and no breeding was found on the drained sections. On the undrained areas between the railroad and the county road several broods were discovered.

Lacy Township.

Lacy township is in Ocean county and extends from Cedar creek south to Oyster creek. It contains about 2,400 acres of virulent mosquito breeding salt marsh. The direction of the prevailing summer winds is such that Forked River, Lanoka, Bayville, Toms River and Lakehurst on the mainland, and Seaside Park, Laval-

lette, and even Bay Head on the shore strip get a large percentage of their mosquito supply from this area.

A general survey was made in the latter part of September, and the plans were ready early in November, 1911, when the Lacy township board of health was served with the necessary notices, blue-prints, &c. No action was taken by that body until December 2d, after the various owners had been notified and the returns from the board of health and township committee were received as required by law. The director was asked to set aside out of the available appropriation the sum necessary to drain about 2,400 acres of the marsh area involved, and advertisements calling for bids were inserted in the New Jersey Courier of Toms River, the Times and Journal of Lakewood and the State Gazette, at Trenton. Bids were received on January 10th, 1912, and the contract assigned to Mr. Jesse P. Manahan, of Red Bank, New Jersey, who was the only bidder, for the sum of $6,800. All the requirements of the law were complied with and work was started on January 24th. Conditions on the meadows at that time were not very encouraging, the weather being very cold and the meadow frozen, the ice in the bay at this time had a thickness of fifteen inches. With all these odds against him the contractor promised to go ahead with the work, although it was not a paying proposition. At that season of the year the people are generally idle and there was no trouble in getting help. On February 2d the work started in good shape; the first thing that was done was to look up all the old ditches which had been cut by the owners years ago. These ditches were frozen to a considerable depth, but after the top ice was broken there was no trouble in getting large pieces of the frozen mud out of them. This method had never been tried before. It had always required considerable labor to clean the old ditches when the mud was loose. As soon as the good results of this kind of work were observed, more men were put to work in order to get over all the old ditches before the thaw came. The real thaw did not come until about the middle of March, and all the old ditches therefore were finished before that time, and many new ones were already in the meadow to take the water as soon as the ice melted.

The ditches that had been put in up to this time caused a marvelous change in the character of the meadow and areas on which water in the past lay for long periods were now dry. An excellent

crop of grass grew up on this area later in the year. The character of the soil is good, and while the rise and fall of tide is not more than a foot, the meadow drains well, so that practically all surface pools are laid dry.

The ditches were cut in such a way as to obtain the best results in eliminating the mosquitoes, and at the same time not to cut up the meadow so as to interfere with the cutting of the salt grass. Therefore, wherever it was possible, ditches were cut in such a way that space enough was left to drive around the ditches instead of cutting them in such a manner as would necessitate their having to be bridged.

The work went on so steadily that enough was completed by February 23d to entitle Mr. Manahan to the first payment. The ditching machine at this time was doing good work, and, as the weather improved, more hand laborers were put on, so that fully half of the 310,000 feet of ditches which was required by the terms of the contract was in the meadow on March 20th, entitling Mr. Manahan to the second payment. Additional help was put on at this time to push the work faster so as to get as much water off as possible before the first brood could hatch from the eggs. This was successfully done, although the work had to be carried on under great difficulties due to heavy rains and high tides which kept the meadows covered with water most of the time. But the ditches did such excellent work that between periods of rains and tides the pools were laid dry and the larvæ in consequence destroyed.

There was no interference by the owners. On the contrary, they assisted in the work whenever they were able and seemed well pleased by the way the ditches were cut and the meadow improved.

The three hundred and ten thousand (310,000) feet of ditching which were required under the contract were put in and do the work in a most satisfactory manner. All the ditches come up to the requirements in every way. The time limit for the contract was May 1st, and it was finished on time.

This meadow was kept under observation more or less during the remainder of the summer and no breeding of any kind was discovered. Adult mosquitoes were plentiful at all times, but traveled from adjoining undrained meadows. One of these sources of supply was the Manahawkin meadow, which has a reputation of being one of the worst breeding places in the State.

Ocean Township.

Ocean township lies along Barnegat bay, in Ocean county. A survey of the marsh territory lying within this township was made in May and it was estimated that it would require about 154,800 feet of 10 x 30 inch and 4,700 feet of 20 x 30 inch ditches to render it safe.

Objections were raised by the owners to having the wide ditches put in, and therefore the existing wide ditches were thoroughly cleaned and the narrow ditches were run into these wherever it was possible to do so. After the Ocean township committee took the required action according to law, advertisements were inserted in the New Jersey Courier of Toms River, Lakewood Times-Journal and the State Gazette of Trenton. Bids were received on July 1st, and the contract was awarded to Mr. Jesse P. Manahan, who was the only bidder, for the sum of three thousand and four hundred dollars ($3,400).

Work was commenced on July 8th and good progress was made until July 25th, when a terrific brood of mosquitoes emerged on the Manahawkin meadows, came into these meadows on a southerly wind, and drove the laborers from their work. Mosquito repellents of all sorts were sent to the men and the work continued. It was finished within the time limit specified in the contract and the desired results obtained.

Union Township (Ocean County).

Union township, in Ocean county, lies along Barnegat bay. The part of marsh lying north of the North Branch of Gunning river, otherwise known as Double creek, was surveyed early in June, and it was estimated that it would require about 162,000 feet of ditching 10 x 30 inch to make it safe. Many old ditches were found on this meadow. Some, which were cut fifty years ago, were very much grown up—in some instances only the line where there was once a ditch could be seen.

To work in harmony with the owners all these old ditches were put into first class condition and excellent results were derived. Some ditches in that section were five feet wide and four feet in

depth when they were first made, but through neglect they were allowed to grow up. These ditches were all recut and cleaned to the original width and depth. Ditches with the outlet in the bay do not amount to much as the seaweed clogs the mouths.

After the Union Township Committee took the required action according to law advertisements were inserted in the New Jersey Courier of Toms River, Lakewood Times-Journal, and the State Gazette of Trenton. Bids were received on July 26th, and the contract was awarded to Mr. Jesse P. Manahan, who was the only bidder, for the sum of two thousand and nine hundred dollars ($2,900). Work was started on August 6th, and good progress was made. The work was finished within the time limit, which was September 30th, and satisfactory results obtained.

Island North of Gunning River (Ocean County).

The section of marsh lying north of Gunning river and south of Double creek in Ocean county was inspected and found to contain a considerable number of mosquito breeding places. On close inspection it was determined that it would not require more than 20,000 feet of ditching to relieve conditions.

The director of the Experiment Station was asked to set aside the sum of five hundred dollars ($500) for the work. An agreement was made with Mr. Manahan to do the work, and the meadow was satisfactorily ditched and drained in due time.

Island South of Gunning River (Ocean County).

The section of marsh lying on the south side of Gunning river and north of Flat creek was inspected and found to contain many mosquito breeding places. After the territory was carefully gone over it was determined that about 29,000 feet of ditching was necessary to relieve this section.

The director of the Experiment Stations was asked to set aside the sum of seven hundred dollars ($700), and an agreement was made with Mr. Manahan to do the required work. Work was commenced immediately after the agreement was made, and everything was done satisfactorily. This work will undoubtedly show good results next year.

Barnegat Bay Problem.

The rise and fall of tide in Barnegat bay is so light that the best results cannot be expected without employing men to attend to the ditches to keep them free from stoppage, which is due mostly to seaweed filling the mouths of the ditches and holding the water back. The same method must be used here as that employed along the Shrewsbury river, where men are employed from March 1st to October 1st to keep the ditches clean. The rise and fall of the tide being twelve inches at the most, holds the water which gets on these meadows by extremely high tides or heavy rains longer than on the meadows in the northern part of the State where the rise and fall of the tide is from four to six feet.

By keeping the ditches open fairly good results can be obtained. The meadows from Bay Head to Forked River have been greatly improved by the ditching, and where a year ago there was a rooted out section which produced no hay it is now yielding a good crop of grass and is bringing in a good revenue to the owners.

The hay merchants are speaking highly of the work and the results. One owner alone has cut forty tons more hay in 1912 than in any previous year, and he gives full credit of this to the ditching and draining that has been done. The same report is practically universal in that region, and as hay brings $10 per ton it means that the hay men realized substantial profit in 1912 from the work of the State on their meadows. The black grass has improved immensely, both in quality and quantity throughout the drained area. If the ditches are kept in the present working condition and no clogging allowed to take place, there will not be much danger of mosquito breeding. If, however, the ditches should be allowed to fill up, good results cannot be expected. Therefore, a county commission is necessary in Ocean county, and it should be one of its duties to see that the ditches are kept open at all times.

Long Beach Township Meadow.

The Long Beach township meadow and the meadows lying within the Borough of Beach Haven were inspected on June 25th. Three days were spent in looking over the nine miles of meadow.

The Long Beach Township Committee and the Beach Haven Borough Council took the matter up early in the season, and each body appointed one member to take charge of the mosquito work and to see that everything was done to keep the mosquitoes down.

As soon as I reached Barnegat City Junction I noticed that the ditches had gotten a thorough overhauling. They had never been in better shape, every one of them had gotten a thorough cleaning. I found later that Mr. H. Earl McConnell had charge of the township ditches while Mr. H. S. Jones supervised the work that was done within the Borough of Beach Haven. It goes without saying that both of these gentlemen knew what they were doing, as shown by the fact that I could not find a single larva on the entire territory.

The little ponds and ditches among the sand dunes were found in the best of condition. Although these ponds were cut five years ago they are still in as good condition as when first made. The fish that were introduced into them have multiplied considerably.

Adult mosquitoes were found, however, quite abundant, but it is a well-established fact that they did not breed anywhere on Long Beach. The entire supply came from the mainland on the west side of the bay on the westerly winds, and such conditions will continue to exist until the Manahawkin and Tuckerton meadows are cleaned up.

Woodbine (Cape May County).

At the request of Prof. Sabsovich, of the De Hirsch Fund Agricultural School of Woodbine, a survey of the area involved and an estimate of the cost of eliminating the salt marsh mosquitoes from Woodbine was prepared. Woodbine is located so that no matter which way the wind happens to blow salt marsh mosquitoes will be blown into town. This meant that a thorough inspection and survey had to be made along the Delaware bay as well as along the

east and south coasts and up Tuckahoe creek as far as the salt marsh continues.

It was seen at the beginning that a large amount of labor was involved in covering those vast tracts of meadows. The start of the inspection was made by myself on March 4th at Riggings ditch, in Cumberland county, which was considered the extreme southwest point from which Woodbine would be affected. The surveys were continued along the Delaware bay to Green creek, which is the extreme southeast point of danger, and then the work along the coast and up Tuckahoe creek was continued and every point carefully inspected. The condition of the soil and rise and fall of tide were also noted. It was found that every portion of meadow on the Delaware bay, as well as on the coast, could be drained with the best results. Creeks and thoroughfares are numerous everywhere with the exception of two sections on the Delaware bay side, and the fall of the tide is from three to five feet, sufficient to drain any part of the meadows completely.

A total of forty-seven miles of salt meadow land ranging from 1,000 feet to five miles in width was gone over.

To free Woodbine of the salt marsh mosquitoes meant that this entire salt marsh area would have to be ditched, involving the construction of 4,000,000 feet of ditches, at a cost of about $85,000. Woodbine, Cape May, Holly Beach, Wildwood, Stone Harbor, Sea Isle City and all the inland sections between these points would be benefited by this drainage.

The directors of the De Hirsch fund would be willing to contribute towards the work. With the help of State funds it was at first thought that some work could be done in 1912, but after the survey was made, and the estimate of cost delivered to the directors of the De Hirsch fund, they at once agreed that the task was so large as to be quite outside their reach.

The only way this work could be done would be to secure a larger State appropriation. And, incidentally, it may be said that the draining of this area should not be begun until a sum sufficient to do the whole at one time is available; for any single section drained would not give relief, and so the work of the State would be likely to be discredited.

The Legislature of 1912 passed an act providing for the appointment of county mosquito extermination commissions and

placing the problem of controlling local breeding in their hands. The act became a law on March 12th, 1912. The text of this act follows:

Chapter 104, Laws of 1912.

An act for the establishment of county mosquito extermination commissions and to define their powers and duties.

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. In any county of this State it shall be the duty of the justice of the Supreme Court presiding over the courts of said county to appoint six persons, three of whom must be persons who are or have been members or employes of boards of health. A board of commissioners to be known as "The County Mosquito Extermination Commission," inserting the name of the county in and for which the commissioners are appointed. The commissioners first appointed under the provisions of this act in any county shall hold office respectively for the term of one, two and three years, as indicated and fixed in the order of appointment, and all such commissioners, after the first appointment, shall be so appointed for the full term of three years; vacancies in the said commission occurring by resignation or otherwise shall be filled by such justice, and the persons appointed to fill such vacancies shall be appointed for the unexpired term only; such persons so appointed, when duly qualified, constituting such commission and their successors are hereby created a body politic, with power to sue and be sued, to use a common seal and make by-laws; the members of any such commission shall serve without compensation, except that the necessary expenses of each commissioner for actual attendance on meetings of said commission shall be allowed and paid. No persons employed by the said commission shall be a member thereof; before entering upon the duties of his office each commissioner shall take and subscribe an oath or affirmation before the clerk of the county in and for which he is appointed, to faithfully and impartially perform the duties of his office, which oath or affirmation shall be filed with the clerk of the county wherein the commission of which he is a member is appointed; every such commission shall annually choose from among its members a president and treasurer, and appoint a clerk or secretary and such other officers and employes as it may deem necessary to carry out the purposes of this act; it may also determine the duties and compensation of such employes, and make all rules and regulations respecting the same. It shall be the duty of the board of chosen freeholders in each county to provide such commission with a suitable office where its maps, plans, documents, records and accounts shall be kept, subject to public inspection at such times and under such reasonable regulations as the commission may determine.

2. The director of the State Experiment Station shall be a member ex-officio of each commission and shall co-operate with them for the effective carrying out of their plans and work. The said director shall serve without compensation, except that the necessary expenses actually incurred by him in the attendance on meetings of said commissions shall be allowed and paid. He shall furnish the said commissions with such surveys, maps, information and advice as they may require for the prosecution of their work, or, as in his opinion, will be of advantage in connection therewith.

3. Every such commission shall have the power to eliminate all breeding places of mosquitoes within the county wherein it is appointed, and to do and perform all acts and to carry out all plans which in their opinion and judgment may be necessary or proper for the elimination of breeding places of mosquitoes, or which will tend to exterminate mosquitoes within said county.

4. Said commission shall, on or before the first day of April in each and every year, file with the director of the State Experiment Station a detailed estimate of the moneys required for the ensuing year, and a plan of the work to be done and the methods to be employed. The said director shall have the power to approve, modify or alter the said estimates, plans and methods, and the estimate, plan and method finally approved by him shall be by him forwarded to the board of chosen freeholders in each county on or before the first day of May following its receipt.

5. It shall be the duty of the board of chosen freeholders of each county, or other body having control of the finances thereof, to include the amount of money approved by the director of the State Experiment Station, annually in the tax levy; *provided, however*, that in no year shall the amount so raised exceed the amount hereinafter specified, to wit, in counties where the assessed valuations are not more than twenty-five million dollars, a sum not greater than one mill on every dollar of assessed valuations; in counties where the assessed valuations are not more than fifty million dollars a sum not more than one-half of one mill on every dollar of assessed valuations; in counties in which the assessed valuations are in excess of fifty million dollars a sum not more than one-quarter of one mill on every dollar of assessed valuations.

6. The moneys so raised, or so much thereof as may be required, shall be paid from time to time to the said mosquito commission on the requisition of said commission, duly signed and approved by the president and secretary thereof.

7. It shall be the duty of each commission annually, on or before the first day of November in each year, to submit to the director of the State Experiment Station and to the board of chosen freeholders in their respective counties, a report setting forth the amount of moneys expended during the previous year, the methods employed, the work accomplished and any other information which in their judgment may seem pertinent.

8. Nothing in this act shall be construed to alter, amend, modify or repeal the provisions of chapter 134 of the laws of 1906, or alter, amend, modify or repeal any act now existing conferring upon State or local boards of health any powers or duties in connection with the extermination of mosquitoes in said State, but shall be construed to be supplementary thereto.

9. This act shall take effect immediately.

Approved March 21st, 1912..

According to this act each county commission may use the following maximum funds:

Counties.	U. S. census 1912 population.	Assessed ratables.	Rate part of mill.	Amount received at rate.
Atlantic	71,894	$88,685,867 00	.000¼	$22,171 47
Bergen	138,002	109,634,724 00	.000¼	27,408 64
Burlington	66,565	31,873,587 00	.000½	15,936 79
Camden	142,029	81,368,788 80	.000¼	20,342 20
Cape May	19,745	27,676,166 00	.000½	13,838 08
Cumberland	55,153	24,436,284 00	.001	24,436 28
Essex	512,886	552,348,996 00	.000¼	138,087 25
Gloucester	37,368	23,287,959 00	.001	23,287 96
Hudson	537,231	495,065,748 00	.000¼	123,766 44
Hunterdon	33,569	21,142,112 00	.001	21,142 11
Mercer	125,667	93,619,955 00	.000¼	23,404 99
Middlesex	114,426	62,907,962 00	.000¼	15,726 99
Monmouth	94,734	96,497,913 00	.000¼	24,124 48
Morris	74,704	47,967,930 00	.000½	23,983 97
Ocean	21,318	17,675,496 00	.001	17,675 50
Passaic	215,902	160,978,641 00	.000¼	40,244 66
Salem	26,999	16,382,917 00	.001	16,382 92
Somerset	38,820	30,294,704 00	.000½	15,147 35
Sussex	26,781	15,626,401 00	.001	15,626 40
Union	140,197	144,344,797 36	.000¼	36,086 20
Warren	43,187	24,918,687 00	.001	24,918 69
Totals	2,537,177	$2,166,735,635 16		$683,739 38

Owing to the lateness of the passage of this act only two county commissions were able to get to work during the season that followed. These were Essex and Union, and the results obtained in these counties were of such a nature as to encourage the rest of the State.

For the purpose of meeting demands for aid made on this office by the newly-appointed county commissions and of keeping a closer watch of the salt marsh work, Mr. Henry H. Brehme was reappointed April 1st and was retained throughout the year. With this force we have been able to meet the calls thus far.

The report of Mr. Herman H. Brehme on the formation of the county mosquito commissions and of the activities of this office therewith follows:

COUNTY MOSQUITO EXTERMINATION COMMISSIONS.

By HERMANN H. BREHME.

Essex County.—The Essex County Mosquito Extermination Commission was appointed in April and was the first commission in the State.

The work was taken up at once by the commission and money was asked from the freeholders as prescribed in the law. The amount asked for was seventy-five thousand and one hundred dollars ($75,100), although under the law the commission was entitled to $138,087.25.

The appointments of inspectors and laborers were immediately made and actual work was commenced on May 13th. The maps on which the local breeding places were marked and which were made by myself under Dr. Smith's direction in 1910-11 were turned over to the commission to give them a start.

A chief inspector, one deputy chief and forty-three regular inspectors were appointed, and the work of locating breeding places was taken up. The best work done by the inspectors was the house-to-house inspections by means of which many isolated breeding spots were found and done away with. As soon as a breeding place was discovered it was reported to the chief inspector and immediate action was taken either to oil or to eliminate the danger spot entirely. After a number of breeding places were located a force of laborers was put on and ditching was done when possible, while other places were kept oiled. The sewer catch-basins were kept well covered with oil and the meadows were also looked after throughout the season.

The writer attended most of the meetings of this commission and gave whatever advice was asked or necessary.

Union County.—The Union County Commission was appointed in April and got to work without delay.

Inspections were made throughout Union county during the winter of 1911-12 by Mr. Henry H. Brehme, and 140 open breeding places, such as lot pools, swamps, brooks, &c., were located, and a list of the same was sent to Mr. Louis J. Richards, secretary of the Union County Mosquito Extermination Commission.

Early in May I attended one of the meetings of the commission and informed the members how to obtain the best results, and my suggestions were carried out to a certain extent.

Inspectors were appointed in June, and it was thought best by the commission to get men that had a little knowledge of mosquito extermination work. The men selected were students from Rutgers College, and they proved to be very satisfactory in every way.

Mr. Henry H. Brehme was sent over the Union county territory with the men, and thereafter he made inspections every two or three weeks to take notes as to how the work was progressing, and his reports on conditions were very satisfactory. They showed that a great deal of work was being done, on the whole, as well as could be expected for the first season. Some districts were practically mosquito free; others, however, were infested to a great extent. There is only one thing to blame for such conditions, and that is an insufficient number of inspectors were put to work. In some cases one inspector had twenty-five square miles as his district, which was entirely out of proportion to the work he could do.

The force of help in Union county consisted of a chief inspector and eight deputy inspectors with a small number of laborers, which is insufficient for a county of that size.

The money expended by the Union County Commission by September was less than sixteen thousand dollars. The amount appropriated by the freeholders was $28,000. The biggest part of the balance of the money left over will be used early next spring.

Passaic County.—The Passaic County Commission was appointed in April, and while no money was appropriated for 1912, assistance was asked from the State to locate breeding places. This work was assigned to Mr. Henry H. Brehme, who made a general inspection in Passaic, Paterson, Allwood, Clifton and Delawana. More than sixty open breeding places, such as dumps, swamps and brooks, where breeding was going on were located, and a report on these conditions, with cost to eliminate them, was submitted to the commission.

Camden County.—A commission was appointed for this county, but not in time to get money to do any work in 1912. To get a sort of a start for next year, assistance from the State was asked

to locate breeding places. Mr. Henry H. Brehme was sent to investigate the cause of trouble, and made a report on the conditions as found.

The main trouble in this county is the house mosquito, *C. pipiens*, and conditions in the city of Camden are just ideal for this species, with the dumping grounds, cesspools and sewer catch-basins that exist there. The problem in Camden county is a local one, and if the work is properly done by the commission next year there should be very few mosquitoes.

A series of maps indicating the most prolific breeding places, and a report on the conditions along with an estimate of the cost of eliminating the places, was submitted to the commission.

Gloucester County.—The Gloucester County Commission was appointed, but, like Camden county, too late to get an appropriation to work on for 1912.

Help was asked from the State to assist in locating mosquito breeding places. A general inspection was made and a report with maps indicating the most prolific breeding spots was submitted to the commission.

The problem in this county is a local one, and good results can be obtained if the work is taken properly in hand.

Everything is ready to start work and good results can be shown in 1913 providing the money is appropriated.

Mercer County.—A commission was appointed in Mercer county in July. No work has so far been done by the commission, but assistance was asked from this office, and a good part of the county was inspected.

The most prolific mosquito breeding places that were discovered were marked on large maps and a written report with cost to eliminate such breeding places was submitted to the commission.

Work can be begun as soon as the money is provided by the freeholders.

Hudson County.—This county has had a commission since May, but no money was provided to do work during the past season. In August the freeholders set aside $32,250 for mosquito work. No work can, however, be done until after December 1st, when a new fiscal year for that county begins.

Inspections were made throughout the county and breeding places were reported to Mr. William Delaney, chief inspector.

Everything is planned and the work ready to be started promptly after December 1st.

Middlesex County.—The commission for this county was appointed in August. No work has so far been done, and no money has yet been provided by the freeholders.

Breeding places were located by Mr. Henry H. Brehme and marked on maps, and these, along with a written report as to how to deal with the most prolific places and estimates of the cost of elimination of the various places, was submitted to the commission.

The following counties now have commissions: Atlantic, Camden, Cape May, Essex, Gloucester, Hudson, Mercer, Middlesex, Morris, Passaic, Sussex, Union and Warren.

Only three of these thirteen counties are provided with money—Essex, Union and Hudson. The rest of the counties have not up to date received any appropriation, in most cases the result of the fact that the commission was appointed too late to get its amount in this year's budget of the various boards of freeholders.

LARVICIDES. CALCIUM CARBIDE.

By Harry B. Weiss.

Of late years, in connection with the mosquito work, this material has often been suggested as a larvicide. In order to determine its value along these lines it was therefore given a trial in the laboratory and in the field.

Calcium Carbide is used commercially in making acetylene for illuminating purposes. Upon placing it in water, the following reaction takes place:

$$CaC_2+2H_2O=C_2H_2+Ca(OH)_2$$

At medium temperatures acetylene dissolves in an equal volume of water, and when made from commercial carbide usually contains small amounts of hydrogen phosphide and sulphide.

The slaked lime $Ca(OH)_2$ formed, being only slightly soluble in water, falls to the bottom, and the carbon dioxide of the air, acting on the surface of this lime water, forms a thin film of insoluble calcium carbonate.

In the following experiments, larvæ and pupæ of *Culex pipiens* were transferred to different sized jars containing water, which had been standing several days. Upon placing the carbide in these jars a violent bubbling took place, during which the larvæ were churned considerably for a few seconds. The temperature of the water went up two degrees during the operation. It was also noted that the larvæ in the jars no longer rotated their brushes after the carbide had been put in.

JAR 1. Contained 50 larvæ, all sizes. Water, 3.5 inches high, 3 inches in diameter. Area of surface, 7.06 square inches. Amount water in jar, 24.74 cubic inches; 3 grams of calcium carbide placed in jar at 7 A. M.

The surface film started to form immediately after the gas had been given off. At the end of fifteen minutes the movements of many larvæ were sluggish and some came to the top, head end up. At the end of one hour only ten were alive. These were at the top and moved sluggishly when disturbed. The remainder were motionless at the bottom. At 9 A. M. all were dead.

JAR 2. Contained 50 larvæ, all sizes. Water, 3.5 inches high, 3 inches in diameter. Area of surface, 7.06 square inches. Amount water in jar, 24.74 cubic inches; 1 gram of calcium carbide placed in jar at 7:10 A. M.

At 8:10 A. M. a thin film covered the surface. Five larvæ were very active and a few sluggish. Most of them were dead. At 8:30 A. M. only three were alive, and these could not break through the film. The water was fairly clear; most of the $Ca(OH)_2$ having settled. At 9 A. M. all were dead and at the bottom.

JAR 3. Contained 50 larvæ, all sizes. Water, 3.5 inches high, 3 inches in diameter. Area of surface, 7.06 square inches. Amount of water in jar, 24.74 cubic inches; 2 grams of calcium carbide placed in jar at 7:20 A. M.

At 8:20 A. M. only ten were active. Quite a few were at the top with the tips of their siphons projecting above the surface film. It had hardened and held them prisoners, besides contracting and cutting off the air supply. The active ones had great difficulty in breaking through the films and very seldom succeeded. Water rather cloudy. At 9 A. M. all were dead.

JAR 4. Contained 200 larvæ, all sizes. Water, 2 inches high, 8.5 inches in diameter. Area of surface, 56.74 square inches.

Amount of water in jar, 113.49 cubic inches; 4.7 grams of calcium carbide placed in jar at 9 A. M.

At 9:45 all larvæ were dead and at the bottom. Water fairly clear. Film *thin and broken in places.*

JAR 5. Contained 300 larvæ, all sizes, and ten pupæ. Water, 5.5 inches high, 7.5 inches in diameter. Area of surface, 44.17 square inches. Amount of water in jar, 242.98 cubic inches; 10 grams of calcium carbide placed in jar at 8:35 A. M.

At 9:05 A. M. many of the larvæ were sluggish. Water too cloudy to see if any were dead at bottom. At 9:35 A. M. all pupæ were dead, bodies relaxed and not curled. Only fifteen larvæ alive. Many were fastened by their siphons in the film, and when released sank to the bottom. At 10:10 A. M. all were dead.

JAR 6. Contained 150 larvæ, all sizes, and ten pupæ. Water, 1.5 inches high, 9 inches in diameter. Area of surface, 63.61 square inches. Amount of water in jar, 95.42 cubic inches; 4 grams of calcium carbide placed in jar at 8:45 A. M.

After the film had formed it was broken continually so as to create air spaces for the larvæ. At 9:15 A. M. the pupæ were all dead. Only few larvæ alive, and these were sluggish. At 9:45 A. M. only four larvæ were alive. At 9:55 A. M. all were dead despite the air spaces.

JAR 7. Contained 150 larvæ, all sizes, and six pupæ. Water, 1.5 inches high, 9 inches in diameter. Area of surface, 63.61 square inches. Amount of water in jar, 95.42 cubic inches; 1 gram of calcium carbide placed in jar at 10 A. M.

At 11 A. M. only ten larvæ were dead, and all the pupæ were alive. Only a thin broken film had formed and larvæ had collected at open spaces. At 2 P. M. all but ten larvæ were dead. Pupæ all lively. At 4:30 P. M. pupæ only were alive. Film still showed plenty of breaks at which pupæ had collected. A 7 P. M. adults emerged from all pupæ.

JAR 8. Check, 150 larvæ, six pupæ, all alive.

Summary.

In all the jars except No. 7 the carbide acted fairly satisfactorily. In jars 2, 4, 5 and 6 one gram was used for every twenty-four cubic inches of water, irrespective of surface areas. This

amount did fair work. In all the jars except 7 the larvæ and pupæ were all dead within a maximum time of two hours.

The acetylene evidently poisons them somewhat, and probably the particles of calcium hydroxide exert some influence. The film helps considerably, but larvæ died even when this was broken.

At the rate of one gram for every twenty-four cubic inches of water, it would take about twenty pounds to treat a pool with a surface area of 144 square feet and one foot deep. Considering that ten ounces of kerosene would do just as effective if not better work at a lower cost, it does not seem as if calcium carbide has much to recommend it.

However, in spite of its drawbacks the following field tests were made.

Five pounds of calcium carbonate were distributed along the grassy edges of a pool ten feet square and ten inches deep, at National Park. As near as possible one gram was used to every twenty-four cublic inches of water. The water was comparatively fresh, and the only movement was that caused by the wind. Larvæ of *Culex sylvestris* were found in the little gulfs opening into the pool. Three days after the application larvæ were still present, and only a trace of the film remained entangled in the grass. It was thought that the grass would serve to hold it, but such was not the case.

At Westmont a pool twelve feet long, four feet wide and three inches deep, in which *Culex pipiens* was breeding, was treated with the carbide at the same rate. The material was distributed as evenly as possible, and at the end of one hour a slight film had formed. This was of varying thickness, it being impossible to distribute the carbide with any degree of exact uniformity. The film did not spread, but formed thick and thin, directly over the carbide. Three days later no absolute trace of it remained, and larvæ were still plentiful. In view of such unsatisfactory results it is safe to say that calcium carbide is entirely without merit as a larvicide.

Four different brands of oil intended for the destruction of mosquito larvæ were tested by Mr. Hermann H. Brehme, but none gave satisfactory results. Fuel oil costing about five cents a gallon has proven generally satisfactory.

MOSQUITOES OF THE SEASON AND MISCELLANEOUS INSPECTIONS.

By Hermann H. Brehme.

Mosquitoes of the Season.

The summer of 1912 was a normal one until the first part of August, when heavy showers set in, a condition favorable for prolific production of mosquitoes. Complaints were received from the southern part of the State, and especially from along Barnegat bay. Upon investigation the species most troublesome proved to be *Culex sollicitans.* In the northern section it helped *Culex pipiens* along, but remained very rare in this part of the State all season.

The house mosquito, *C. pipiens,* was nearly absent in Essex.

Culex sylvestris appeared in vast swarms through Essex, Hudson and Union counties in May and June, and these were at first all taken for *cantator* by the local inspectors until the difference was pointed out.

Culex triseratus was found both in Union and Essex counties, mostly in tree holes; only on one occasion has it been found in a rain-water barrel during the past season.

Culex pretans occurred in great numbers in the early spring in the Great Piece meadows. After the first hatching trouble began with this species which continued throughout the season.

Culex restuans was not abundant, and only odd specimens were taken near the Ebling meadow in Newark.

Culex salinarius was very rare all season with the exception of September, when a considerable number were found on one section of the Newark meadow. The facts that this is a northern species, and that its breeding places in the Newark meadow are rapidly being eliminated, mean that this mosquito will soon become rare.

Culex cantator was not as abundant in the northern part of the State as in 1911. In the southern portion, however, it was very plentiful and exceedingly large. The first brood hatched early in May and held on for nearly six weeks. No more hatching took place until early in September, when it appeared in association with *sollicitans.* It was not the predominate form as in previous years, *sollicitans* outnumbering it ten to one.

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Culex sylvestris appeared in vast swarms through Essex, Hudson and Union counties in May and June, and these were at first all taken for *cantator* by the local inspectors until the difference was pointed out.

Culex triseratus was found both in Union and Essex counties, mostly in tree holes; only on one occasion has it been found in a rain-water barrel during the past season.

Culex pretans occurred in great numbers in the early spring in the Great Piece meadows. After the first hatching trouble began with this species which continued throughout the season.

Culex restuans was not abundant, and only odd specimens were taken near the Ebling meadow in Newark.

Culex salinarius was very rare all season with the exception of September, when a considerable number were found on one section of the Newark meadow. The facts that this is a northern species, and that its breeding places in the Newark meadow are rapidly being eliminated, mean that this mosquito will soon become rare.

Culex cantator was not as abundant in the northern part of the State as in 1911. In the southern portion, however, it was very plentiful and exceedingly large. The first brood hatched early in May and held on for nearly six weeks. No more hatching took place until early in September, when it appeared in association with *sollicitans.* It was not the predominate form as in previous years, *sollicitans* outnumbering it ten to one.

Culex sollicitans made its appearance as the first brood of *cantator* was disappearing, according to its usual habit. This species was very rare in the northern part of the State until September, when a fair-sized brood emerged on the Newark and Elizabeth meadows. In the southern part of the Sate it was very abundant most of the season. In fact, its attacks were so ferocious that horses broke their harness to get away from the torture.

The people claimed that mosquitoes have not been as bad in twenty years.

Culex territans was found abundantly in the fresh water pools, particularly in spring water. In the northern section of the State this species will soon disappear, as its breeding places are being eliminated very rapidly since the county mosquito extermination commissions have begun work.

Culex dupreei was found abundantly in July along the edge of the Great Piece meadows and was rather troublesome for a period of three weeks.

Culex subcantans made its appearance in the Millburn-Short Hills section as usual. A considerable number were taken by the Essex county inspectors and claimed to be *cantator*. The breeding places for this species are being eliminated and it will soon be rare in that section.

Culex abfitchii. This species associates with *subcantans* and was found plentiful in the Millburn-Short Hills section. This was probably the last chance this species had in that vicinity. Next year its breeding spots will be eliminated.

Culex canadensis occurred quite generally throughout the wooded portions of the State, and in some places in exceptionally large numbers, especially so in the western section of Essex and Union counties.

Miscellaneous Inspections.

Irvington.—The first spring inspection was made by Mr. Henry H. Brehme on March 11th, to determine what improvements had been made to eliminate mosquito breeding places.

A general inspection was made through the town. Out of twelve places which had previously been reported to the board of health only two were eliminated on that date.

Conditions on March 27th were found about the same and no additional improvements had been made.

A house-to-house inspection was made on this date within a radius of about a quarter of a mile. The result was the finding of thirty-two mosquito breeding places in seven buckets, one old well, eight barrels, one pail, three paint pots, one keg, one milk can and one cellar. These conditions were duly reported to the health officer.

On April 17th another house-to-house inspection was made and a total of thirty places, such as cisterns, old wells, tubs, barrels, &c., were located and conditions reported to the health officer.

The owners of these breeding places were notified to eliminate them within ten days by the board of health.

On May 4th an inspection was made to locate open breeding places that had not already been reported. Four additional dangerous places were found and reported in the usual way.

Seven more places were found on May 13th. By this time *pipiens* were laying eggs and a number of egg-boats were found. Two inspectors, employed by the Essex County Commission, were assigned to this section on this date, but our inspections were continued for our own benefit and future references.

Another inspection was made on June 28th in one section of the town and six breeding places were found which had been overlooked by the county inspectors. The matter was at once reported to the health officer, Mr. Clickinger, who, in turn, notified the chief of the county inspectors.

Several more inspections were made later in the season and in most instances conditions were found to be reasonably good.

Irvington never was as free from mosquitoes as in the past season.

Nutley.—This town is known to be a mosquito-ridden place. A thorough overhauling was made by Mr. Henry H. Brehme during the winter months and early spring.

A total of six inspections were made, everything was carefully looked over and a total of fifty-seven of the most prolific mosquito breeding places were found. A note was made of each place and these were submitted to the board of health with the best suggestions to eliminate the places. While a thorough inspection was made on the open places, no house-to-house inspection was undertaken.

Nutley is one of the places where criticism predominates, and therefore a most thorough inspection was suggested to determine how much breeding was going on within the town. The results of this inspection shows that more open swamps and mosquito breeding places are located within the boundaries of Nutley than in any other section of its size in the State.

While Nutley gets an occasional flight of salt marsh species early in the season, its main trouble is a local one, and if everything is properly cared for there will be very little complaint.

The Essex County Mosquito Extermination Commission took charge of the work about the middle of May, and while mosquitoes were kept pretty well under control, occasional flights would swamp the town. In almost every case *Culex pipiens* was the cause of the trouble.

A thorough piece of work will have to be done by the commission before this town will be entirely free from mosquitoes.

South Orange Township.—This section was well looked over and three full days were spent during the winter locating mosquito breeding places. South Orange township, which includes Hilton and Maplewood, has been having trouble with *pipiens* and *Anopheles* for some time, and a thorough inspection was made. No less than thirty different breeding places were located and reported to Dr. G. Herbert Taylor, health officer of the township.

Most of these places had to be oiled during the past season. At present filling in is gradually going on.

While there was no house-to-house inspection made, it is safe to say that a good many barrels and tubs could be found in yards and on farms.

After the Essex County Commission took charge of the work such inspections were made and many barrels and other receptacles in which mosquito breeding was going on were found.

Only three inspections were made during the summer, and many *Anopheles* as well as *pipiens* were found in the different sections.

South Orange Village.—Six inspections were made here by Mr. Henry H. Brehme from October 23d, 1911, to March 6th. Five of these were made to locate open breeding places, and the other was a house-to-house inspection.

A total of twenty-two prolific *pipiens* and *Anopheles* breeding

places were found and reported to Dr. A. C. Benidict, health officer of South Orange.

On March 5th a house-to-house inspection, of which back yards were the main objects, was made. On a one-day tour no less than forty barrels and tubs that hold water practically all the year were found. This alone was enough to supply the village of South Orange with *pipiens*.

On April 1st another such inspection was made and ten cesspools, two barrels, one tub, a lot of old paint pots and cans were found. A complete list of names of persons on whose premises a barrel or tub was found was made and submitted to Dr. Benidict, who in turn notified the owners of these mosquito breeders either to get rid of the nuisance entirely or empty the barrels every week.

These inspections were made early enough to have everything in good shape before any hatching took place.

The Essex County Commission took charge of the work after the middle of May, and while mosquitoes were kept down to a certain extent, it was no trouble to find larvæ in open places, showing that the work was not done as thoroughly as it should have been.

South Mountain Reservation.—On the request of Mr. Alonzo Church, secretary of the Essex County Park Commission, that we instruct one of its employes to look for mosquito larvæ and advise him as to the best methods to eliminate the breeding places within their jurisdiction, Mr. Henry H. Brehme was sent to the South Mountain Reservation on April 12th, where he met Mr. O. E. Shaller, and with him went over a good portion of the Essex County Park property.

Breeding of the woodland species, which in fact are the only troublesome mosquitoes in that region, was going on at the time and there was no trouble in showing Mr. Shaller how and where mosquitoes breed.

A gang of men was put to work cleaning out the ditches, which get filled in the fall with dry leaves, and pools which had no connection with ditches were ordered filled in. This sort of work was kept up throughout the season and good results obtained.

The Essex County Park Commission has always followed closely the suggestions made to them by the late Dr. Smith and his assistants, and has generally obtained the best results.

Bloomfield.—Bloomfield has been comparatively free of mos-

quitoes all season, but a number of small flights got into town on several occasions. As was found out later, this was due to the neglect on the part of the county inspector. After mosquitoes became troublesome Mr. Henry H. Brehme was sent to investigate matters. He located the breeding places where the trouble originated, and a report was made to the Essex County Commission of the conditions as they were found. The commission took immediate action and checked the breeding.

Belleville.—Two inspections were made in this town, one on April 20th, when considerable numbers of *sylvestris* were found, and another on July 19th, at which time *pipiens, sylvestris* and *Anopheles* were discovered. The county inspectors were at work previous to July 19th, but breeding was found. Conditions were reported to the Essex County Commission.

Essex Fells.—Two inspections were made here, one on April 4th and the other on July 14th. Breeding was found on both days, and the predominating species were *sylvestris, pipiens* and *subcantans.* The Essex County Commission did work in that section during the past season.

Montclair.—Two inspections were made in Montclair, the first on April 25th, and again on May 1st. Breeding was found on both inspections, and conditions were reported to the health officer.

Mosquitoes were not abundant in this town during the past season, due to the good work accomplished by the Essex county inspectors.

East Orange.—Inspections were made here on May 11th and July 8th. Some few *pipiens* were found and conditions were reported to the Essex County Commission. The city of East Orange never was as free of mosquitoes as in the past season, and the credit for this good showing belongs to the Essex County Commission.

Millburn-Short Hills.— Two inspections were made in this section, one on May 2d, the other September 21st. *Sylvestris, pipiens* and *Anopheles* larvæ were found, but nothing compared with former years. Mosquitoes were comparatively rare all season. Good work was done in this section by the county inspectors.

Town of Kearny.—There were several small flights of *pipiens* here, but on the whole conditions were pretty good throughout the season. The health officer, Mr. Amerman, accomplished some

very good work, and by his consistent efforts, kept breeding down to a great extent.

The sewer catch-basins were oiled regularly and open breeding places treated whenever such were found to contain larvæ.

Inspections were made April 3d, May 9th, June 22d, September 10th and 29th. Conditions were always reported to Mr. Amerman.

Harrison.—Besides its sewer basin, Harrison secured a good supply of mosquitoes from some of its open breeding places. It seemed as if the supply was too great for them to handle, so they sent a portion to Newark about August 20th, which made the Essex County Commission give it attention.

Two inspections were made by Mr. Henry H. Brehme during the season.

Jersey City.—No appropriation for city work was made by the Jersey City Board of Health. Mr. Delaney, however, did some oiling with a small sum of money appropriated by the county board of health. Under the circumstances very little money could be used in Jersey City, as the whole appropriation for the county was about $600. Mr. Delaney, however, did the work in an economic way and succeeded in keeping the city comparatively free from local breeding, so that but few mosquito complaints were made.

North Arlington.—North Arlington was inspected several times in early spring and again in September. Some little local breeding was found, but the predominate form seemed to be *sylvestris*; this species was found abundantly on both inspections. Nothing was done to eliminate breeding in that section.

Rutherford.—One inspection was made at this place on request of the Rutherford Improvement Association, and a considerable number of breeding places were located and reported. At first there seemed to be some agitation, but it all died out at once.

Hasbrouck Heights.—At the request of Mr. H. B. Vannote of Hasbrouck Heights several inspections were made in that town. Conditions were looked over carefully and it was determined that *Culex sylvestris* and *pipiens* were the predominating species.

All the help that was needed was given from this office. Breeding places were located, and the gentlemen that intended to take up the fight against the mosquitoes were taken over the ground and instructed as to what to do and how to go about to eliminate

the mosquitoes from Hasbrouck Heights, both privately and by public lecture.

It looked early in the season as if something would be accomplished and everything possible was done to help and to make a success of the planned fight.

Springfield.—Four inspections were made in this town, and while not much breeding was found in the town itself, many breeding places in the immediate vicinity furnished many *sylvestris, pipiens* and *Anopheles.*

Some relief was derived after the Union County Commission got to work in June, and the number of mosquitoes was cut down considerably. Better results will undoubtedly be shown next year for this section, as the work will be started earlier and the heavy woodland crops of mosquitoes will be wiped out.

Westfield.—Westfield got two inspections in July and August. Not much breeding was found, and the mosquitoes were scarce, which was due to the good work of the county inspectors of that district.

Cranford.—Two inspections were made at this place. Both times *pipiens* were found breeding. The crop in this section was smaller this past season than ever before, and it again shows what thorough work will do.

Rahway.—Rahway got only one inspection; on that day enough barrels were located to keep a small force of men busy to oil or to turn the barrels over. Many of the *pipiens* that bred in those barrels undoubtedly escaped before any work was done to clean up, and on some nights made life miserable. This is probably the hardest town to keep free of mosquitoes that is in the jurisdiction of the county commission. However, by strenuous work, they may show good results next season.

Lyons Farms.—Four inspections were made through this territory—*sylvestris, pipiens* and *Anopheles* were the predominating forms. After July, when the Union county inspectors got to work, breeding decreased, and not many mosquitoes were found for the balance of the season.

Union.—Two inspections were made in this town and the first time many larvæ were found. On the second inspection, which took place in August, conditions were better.

This is one of the sections where not enough help is supplied by

the Union County Commission. By putting an additional inspector in this district next season better results should be shown.

Fanwood.—Two inspections were made in this town. Breeding was found in gutters and open lot pools. These places were all reported to the Union County Commission and the breeding was checked.

Lorraine.—Lorraine was inspected on April 22d and *sylvestris* and *canadensis* larvæ were found. Breeding was kept down by the Union County Commission the greater part of the season.

This also applies to Roselle and Roselle Park.

Summit.—Summit is in Union county and could not get help from the Union County Commission. No help or advice, however, was asked from the commission. The health officer, Mr. Pomeroy, took up the fight to keep Summit free of mosquitoes, and did it very successfully.

Mr. Henry H. Brehme was sent into the Summit district several times during the season and always found the work well done. The catch-basins and open pools always had a heavy film of oil on the surface, and if any breeding went on in that town it was in isolated places unknown to Mr. Pomeroy. It is certain that no mosquitoes were bred in open lot pools, swamps or catch-basins in Summit.

New Brunswick.—Only two inspections were made here—August 21st, 22d. A good many breeding places were found which were breeding *sylvestris, pipiens* and *Anopheles.* The breeding places were all marked on maps for the Middlesex County Mosquito Extermination Commission.

Highland Park.—Highland Park was inspected on August 23d and a considerable number of mosquito breeding places were located and noted.

Metuchen.—Inspections were made through this town on August 24th. Many cesspools, catch-basins and gutters were found to contain mosquito larvæ.

Perth Amboy.—This place was looked over on August 27th and many local breeding places were located and marked on the maps for the Middlesex County Commission. The predominating species were *sylvestris, pipiens* and *ciliata.* This was about the only place where *ciliata* was at all numerous.

Sayreville.—Sayreville was inspected on August 29th. Rain-

water barrels seemed to be the most prolific breeding places in this town.

Trenton.—Trenton was inspected on August 7th, 8th and 9th. A number of bad mosquito breeding places were found. The troublesome species were *sylvestris, pipiens* and *Anopheles.* It seemed that the *Anopheles* were more abundant here than in any other part of the State.

White City Park.—An inspection was made in this place on August 13th. Some of the most prolific breeding places in the State are located here, and *Anopheles* seemed to have the upper hand in this section, as more of these were found than of any other species.

Princeton.—This place was looked over on August 14th and many *pipiens* and *Anopheles* breeding places were located and marked on the maps for the Mercer County Commission.

Mercerville, Lawrence, Trenton Junction and *Asylum Station* were inspected on August 15th and 16th. A considerable number of breeding places were located for the Mercer County Commission to work on as soon as they get the appropriation from the chosen freeholders.

Camden.—An inspection was made here. Many cesspools, catch-basins and dumping places were found to contain mosquito larvæ. All these danger points were marked on maps for the Camden County Commission.

Merchantville.—Only one inspection was made in this town and the main trouble seemed to be in the cesspool problem.

City of Gloucester.—Catch-basins and dumping grounds seemed to be the cause for the mosquitoes in that section.

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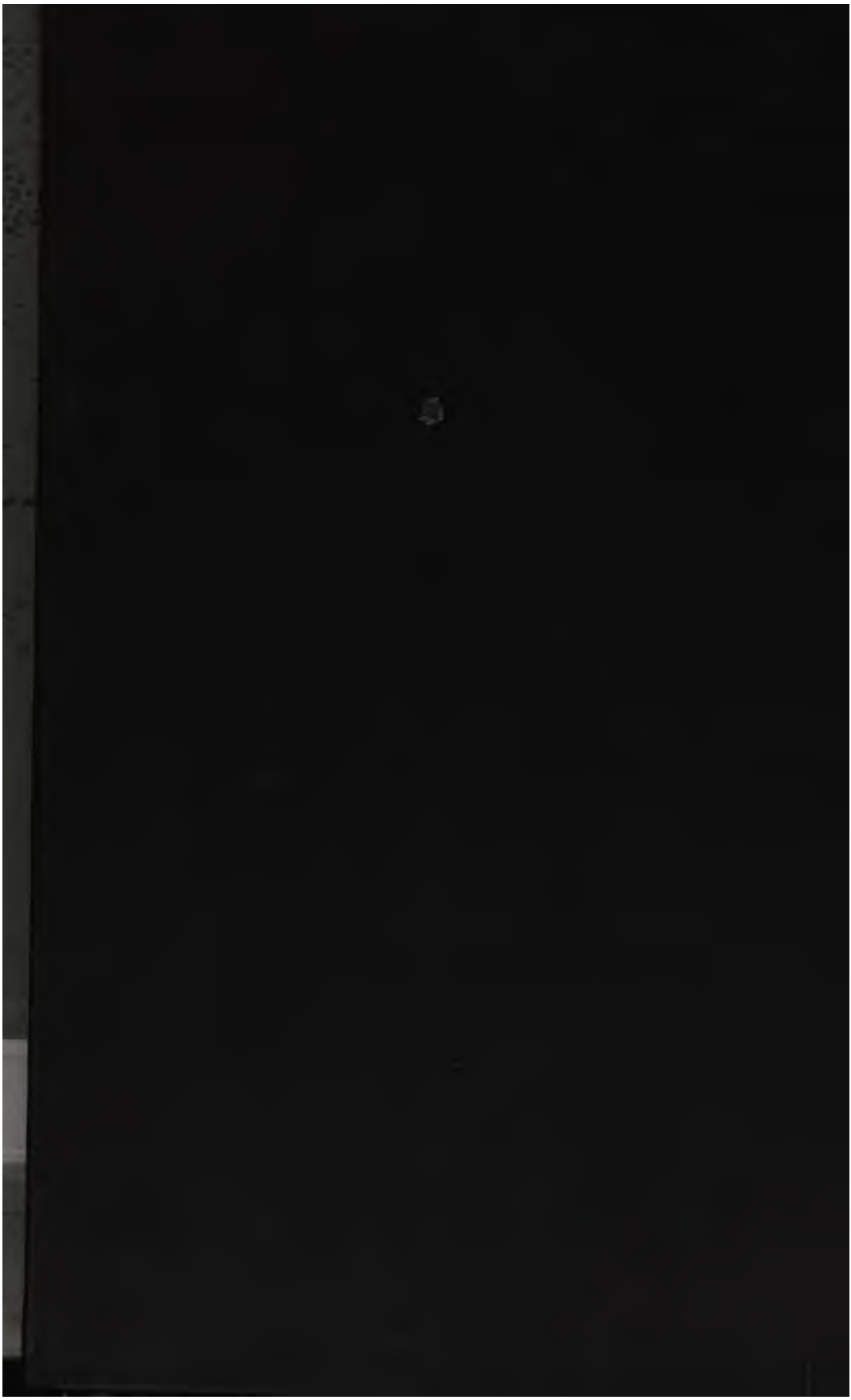
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